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Science Education

The Science Magazine for All Science Teachers

Formerly General Science Quarterly

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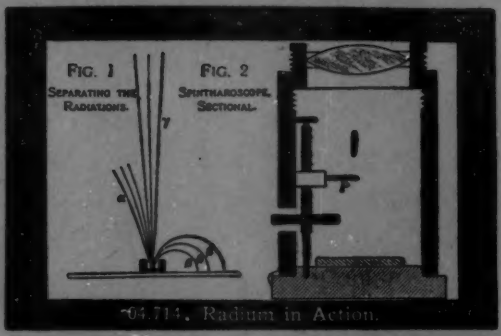

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Vol. XV MARCH, 1931 No. 3

Science Topics that are of Interest and Use to Adults

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Division of Psychology and Educational Research
Los Angeles City Schools

What science topics interest adults? Do editors of magazines and newspapers study the interests of their readers, and secure material to satisfy these interests? An analysis of general newspaper and periodical literature should give a partial idea of general adult interests in science, literature, or any particular field. A more direct method of discovering the interests of adults is to ask specific questions about these interests. In order to secure a foundation for building a science course of study, we in Los Angeles have made several preliminary studies. One concerns itself with the reactions of pupils to their science courses; another with the science interests of junior high school pupils; another with science articles in current periodical literature; another with the science afforded by the immediate environment; and another with adults' interest in and use for science topics. A report of one of these studies is to be found in another number of this magazine. This article will deal briefly with the question of science and the adult.

One of the Los Angeles science course of study committees was assigned the task of discovering the science interests of the parents of junior-high-school pupils. The procedure decided upon was that of providing a check list of twenty-nine science subjects or topics. The following directions were given on the form, which was taken home by the child, checked by the parent, and returned to the school:

> "We are asking your co-operation in an effort to improve the present courses in science. It is desirable to include in a science course of study those things that are of interest and of use to the average adult.
>
> "The following is a list of science subjects. Will you please indicate in the first column by the figures 1, 2, and 3, the three topics which interest you the most. In the second column please indicate in the same manner the three topics of greatest usefulness to you."

The form also contained space for the parents to indicate whether they had had a high school education, and what science subjects they had studied. It will be noted by reference to the tables which follow that technical words were avoided as far as possible.

Table I shows the expressions of approximately 1000 parents regarding science topics of interest and usefulness to them:

TABLE I. *Rating by Parents of Topics According to Interest and Usefulness*

Subjects	*Rank in Interest*	*Rank in Usefulness*
Agriculture	233	239
Animal Life	110	22
Astronomy	116	18
Aviation	307	101
Bacteria	33	23
Chemistry	140	110
Disease	118	60
Earthquakes	14	7
Electricity	292	306
Food	224	305
Fossils	17	6
Forestry	62	34
Heating Systems	41	80
Human Body	249	182
Hygiene	172	156
Insects	23	27
Mechanics	237	250
Lighting Systems	46	99
Oil	58	68
Plant Life	94	54
Radio	239	134
Radium	17	12
Rocks and Minerals	54	24
Sea Life	32	17
Ships and Navigation	66	57
Tides	6	8
Volcanoes	9	7
Water Supply	103	222
Weather	51	49

The five chief interests seem to be aviation, electricity, human body, radio, and mechanics, while the five topics of most use appear to be electricity, food, mechanics, agriculture,

and water supply. Of practically no interest or use to this group of parents are the topics radium, fossils, earthquakes, volcanoes and tides. In order better to compare the topics for interest and usefulness, Table II is given. In this table, the ranks of the topics only are given.

TABLE II. *Rank of Subjects as to Interest and Usefulness to Adults*

Subjects	*Rank in Interest*	*Rank in Usefulness*
Aviation	1	10
Electricity	2	1
Human Body	3	6
Radio	4	8
Mechanics	5	3
Agriculture	6	4
Food	7	2
Hygiene	8	7
Chemistry	9	9
Disease	10	14
Astronomy	11	23
Animal Life	12	22
Water Supply	13	5
Plant Life	14	16
Ship and Navigation	15	15
Forestry	16	18
Oil	17	13
Rocks and Minerals	18	20
Weather	19	17
Lighting Systems	20	11
Heating Systems	21	12
Bacteria	22	21
Sea Life	23	24
Insects	24	19
Radium	25	25
Fossils	26	29
Earthquakes	27	27
Volcanoes	28	28
Tides	29	26

The coefficient of correlation between interest and usefulness of science topics, rho = .827.

Several questions might be asked by the course-of-study worker. Should the junior-high-school science courses take cognizance of the interests of adults? Is usefulness to adults a valid criterion for the selection of the proper materials? Which of the two is the more important? Should a combination of pupils' interests and parents' interests be made? These questions cannot, of course, be answered without qualification. Other considerations are valid.

One might well ask, what is the educational status of the

parents who gave the information? Are these parents interested in the topics in which they should be interested? Have they had an opportunity to be interested in certain of the topics? Are the interests of those who have had a high school education different from those who have not had this opportunity? Do these groups find the same topics of use to them in their lives? Since the information was available regarding the educational status of the parents, it has been possible to prepare the following tables.

Table III shows the interests of four groups, men and women, with and without high school education. The numbers have been reduced to a common basis, inasmuch as there were different numbers in each group.

TABLE III. *Rating of Topics According to Interests of Various Groups*

TOPICS	MEN		WOMEN	
	With H. S. Education	*Without H. S. Education*	*With H. S. Education*	*Without H. S. Education*
Agriculture	34	22	22	17
Animal Life	10	13	10	11
Astronomy	11	14	20	6
Aviation	45	36	36	13
Bacteria	3	4	6	2
Chemistry	26	20	18	4
Disease	12	10	21	11
Earthquakes	1	1	4	1
Electricity	49	38	31	9
Food	23	9	30	45
Fossils	2	2	4	0
Forestry	11	5	12	0
Heat	9	3	5	2
Human Body	24	22	47	23
Hygiene	12	13	45	18
Insects	4	2	2	3
Mechanics	11	32	7	39
Lighting Systems	7	3	8	6
Oil	4	10	3	7
Plants	16	10	16	5
Radio	28	28	23	27
Radium	2	0	6	4
Rocks and Minerals	3	8	3	5
Sea Life	3	2	6	4
Ships	3	6	7	9
Tides	0	0	1	1
Volcanoes	1	0	3	1
Water	14	10	14	13
Weather	4	5	7	8
Number of Parents	148	288	108	191

Table IV gives the tabulation of the usefulness of science topics to these several groups.

TABLE IV. *Rating of Topics According to Usefulness*

TOPICS	MEN		WOMEN	
	With H. S. Education	*Without H. S. Education*	*With H. S. Education*	*Without H. S. Education*
Agriculture	39	27	20	14
Animal Life	3	2	3	2
Astronomy	1	1	4	1
Aviation	18	10	9	5
Bacteria	2	2	3	2
Chemistry	14	18	9	4
Disease	6	4	8	6
Earthquakes	2	0	0	1
Electricity	41	40	34	17
Food	32	17	65	27
Fossils	1	1	1	1
Forestry	7	2	3	1
Heat	9	5	19	7
Human Body	18	17	37	12
Hygiene	9	17	42	12
Insects	3	1	1	2
Mechanics	14	34	13	35
Lighting Systems	20	10	11	8
Oil	4	11	4	7
Plants	5	3	12	4
Radio	16	17	8	16
Radium	1	1	3	1
Rocks and Minerals	1	4	1	3
Sea Life	1	2	1	3
Ships	3	8	3	6
Tides	0	1	1	1
Volcanoes	0	0	1	1
Water	34	23	32	22
Weather	3	5	5	6

In order to make the comparisons more striking, the first ten topics for interest and usefulness have been segregated into the following tables:

Table V gives the first ten interests for the four groups:

TABLE V. *Rank of First Ten Topics According to Interests of Various Groups*

Rank	*Men With H. S. Education*	*Men Without H. S. Education*	*Women With H. S. Education*	*Women Without H. S. Education*
1	Electricity	Electricity	Human Body	Mechanics
2	Aviation	Aviation	Food	Food
3	Agriculture	Mechanics	Hygiene	Radio
4	Radio	Radio	Aviation	Human Body
5	Human Body	Human Body	Electricity	Hygiene
6	Food	Agriculture	Radio	Agriculture
7	Chemistry	Chemistry	Agriculture	Water
8	Plants	Astronomy	Astronomy	Aviation
9	Water	Hygiene	Chemistry	Animals
10	Hygiene	Animals	Plants	Disease

Table VI gives the first ten items in point of usefulness to the four groups.

TABLE VI. *Rank of First Ten Topics According to Usefulness to Various Groups*

Rank	*Men With H. S. Education*	*Men Without H. S. Education*	*Women With H. S. Education*	*Women Without H. S. Education*
1	Electricity	Electricity	Food	Mechanics
2	Agriculture	Mechanics	Hygiene	Food
3	Water	Agriculture	Human Body	Water
4	Food	Water	Electricity	Electricity
5	Light	Chemistry	Water	Radio
6	Human Body	Food	Agriculture	Agriculture
7	Aviation	Human Body	Heat	Human Body
8	Radio	Hygiene	Mechanics	Hygiene
9	Chemistry	Radio	Plants	Light
10	Mechanics	Oil	Light	Oil

How do the reactions of the separate groups compare with the group as a whole? Table VII gives this information.

TABLE VII. *Rank Comparison of Interests of Whole Group and Separate Groups*

Subjects	*Whole Group*	*Men With High. Sch. Education*	*Men Without High Sch. Education*	*Women With High Sch. Education*	*Women Without High Sch. Educaiton*
Aviation	1	2	2	4	8
Electricity	2	1	1	5	0
Human Body	3	5	5	1	4
Radio	4	4	4	6	3
Mechanics	5	0	3	0	1
Agriculture	6	3	6	7	6
Food	7	6	0	2	2
Hygiene	8	10.5	9	3	5
Chemistry	9	7	7	9	0
Disease	10	0	0	0	10
Plants	0	8	0	10	0
Water	0	9	0	0	7
Astronomy	0	0	8	8	0
Animals	0	0	10	0	9

TABLE VIII. *Rank Comparison of Usefulness to Whole Group and to Separate Groups*

Subjects	*Whole Group*	*Men With High Sch. Education*	*Men Without High Sch. Education*	*Women With High Sch. Education*	*Women Without High Sch. Educaiton*
Electricity	1	1	1	4	4
Food	2	4	6	1	2
Mechanics	3	10	2	8	1
Agriculture	4	2	3	6	6

TABLE VIII.—*Continued*

Subjects	*Whole Group*	*Men With High Sch. Education*	*Men Without High Sch. Education*	*Women With High Sch. Education*	*Women Without High Sch. Education*
Water	5	3	4	5	3
Human Body	6	6	7	3	7
Hygiene	7	0	8	2	8
Radio	8	8	9	0	5
Chemistry	9	9	5	0	0
Aviation	10	7	0	0	0
Light		5	0	10	9
Oil		0	10	0	10
Heat		0	0	7	0
Plants		0	0	9	0

It has often been said that science raises questions rather than answers them. A study of the findings relative to interest and use of science topics as determined from parents' reactions to a check list raises more questions than it answers. Can we say that those topics found to be both interesting and useful to adults who have had a high school education should receive first attention in our science courses of study? Should the information gleaned from such a study as this be used in conjunction with information obtained relative to pupils' interests in selecting topics to be taught? Certainly we can say that the topics of most interest and use of adults should find their way into the teaching material. Doubtless other studies must be made, however, with larger numbers of adults and with other techniques before any final decisions can be reached. In the meantime, it is the hope of the writer that this study will prove of some interest and value to those who are actively concerned with science course of study materials.

The Bee's Load

An unladen honeybee can fly about 25 miles per hour, the United States Department of Agriculture estimates, but seldom flies faster than 15 miles per hour. When weighted with nectar, it often flies as rapidly as when unladen, although it sometimes stops to rest on a long journey. Sometimes bees with heavy loads become exhausted when flying over lakes or rivers, fall into the water, and are drowned. A heavily loaded bee sometimes makes an ungraceful landing at the apiary, bumping into the hive or dropping to the ground before it. The load of nectar which the bee brings to the hive varies with the density of the nectar, but the average load is about 40 milligrams, or about half the weight of the bee.

Pupil Errors In Photosynthesis and the Respiration of Plants

Elliot R. Downing
University of Chicago

Teachers in eleven high schools in Illinois, Indiana and Wisconsin taught to their biology classes, last year, a unit on photosynthesis and respiration of plants. The detailed outline for this unit was sent to them by the author. They were requested to teach the unit to the point of mastery so that pupils could be reasonably expected to solve problematic situations that demand the application of the principles learned in the study. When the unit had been so taught an examination, uniform for all schools, was sent to each teacher in sufficient quantity so that each pupil could have a copy. These papers were returned to the author for scoring.

A copy of the examination is here presented:

1. The ..... leaf manufactures food materials. It takes in ..... from the air, water absorbed by the ....and other materials dissolved in the water and combines them to form such foods as ..... These food materials are used by the plant for growth and to furnish the energy needed in its activity. This energy is set free in the plant by the process of ..... Food manufacture can go on only when the plant is in the ..... It is made possible by the green coloring material or ..... which absorbs the energy of the .....
2. What does a plant do in breathing and which experiment showed this? (Answer on the back of the sheet.)
3. If a potted green plant were put into a large air-tight jar, from the air in which the oxygen had been removed, would it live longer in the dark or in the light? Why? Mark with a cross (X) the best answer and below the best reason.
   ( ) In the light. ( ) In the dark. ( ) It would make no difference.
   Best reason. A plant does not need oxygen in the dark.
   Nothing can live without oxygen.
   In photosynthesis a plant gives off oxygen.
   A plant in the light must have oxygen with which to make food.
4. Fungi like toadstools or mushrooms, yeast, and some colorless higher plants like Indian Pipe contain no chlorophyll. How do they get their food? Mark (X) best answer.
   ( ) They do not need any—only green plants need food.
   ( ) They get it already made by other plants, often as decaying organic matter.
   ( ) They have other coloring matter that serves in place of chlorophyll.
   ( ) They live on the dirt, the mineral matter.
5. In an aquarium containing only fish, snails, or other water animals, the water must be changed often. But if water plants are present it need not be changed. Why? Mark (X) the best answer.

( ) Because the plants keep the water clean.
( ) Because the plants serve as food for the animals.
( ) Because the animals breathe off carbon di-oxide which the plants use when they breathe.
( ) Because the plants in the light give off oxygen which the animals need for breathing.

The spaces in question one are to be filled as follows: 1st, green; 2nd, CO_2; 3rd, root hairs; 4th, sugar, starch, proteid, (any one or more); 5th, oxidation; 6th, sunlight; 7th, chlorophyll; 8th, sun.

The answer expected in question two is that in respiration plants take in oxygen and give off carbon dioxide. The experiment may be referred to by name or by number on the unit outline. In question three the possible best answers may be lettered a, b, c,—a being the best one. The best reason may similarly be lettered a, b, c, d,—and c is the best. Similarly lettering the best answers of questions four and five, b is best under four and d under five.

The following tabulation shows the number of errors for each of these items made by the 459 pupils in 11 schools.

I.	Carbon dioxide	29
	Root hairs	70
	Starch, sugar, etc,	32
	Oxidation	266
	Sunlight	29
	Chlorophyll	10
	Sun	109
II.	Nature of respiration	338
	Experiment	300
III.	Best answer:	
	b, times checked,	50
	c	78
	unmarked,	5
	Best reason:	
	a, times checked,	26
	b	85
	d	73
	unmarked	3
IV.	a, times checked,	5
	c	35
	d	40
	unmarked	2
V.	a, times checked,	14
	b	28
	c	76
	unmarked	2
		1705

The total of 1705 errors is an average of 3.7 errors per pupil out of a possible 20. Each question on the test is given a value of 20% to make the total of 100%. The average

grade achieved by the 11 schools is 75.2%, the extremes being 48.8 and 94.1. The school with the highest rating makes only .77 errors per pupil while the largest number of errors per pupil is 4.9.

The very striking thing about the results is the excess of errors in the fourth item of question one and on question two. The answers show that most pupils believe that in breathing plants take in carbon dioxide and give off oxygen. Apparently teachers are not making clear to pupils that photosynthesis and respiration are two distinct processes and that the energy which the plant uses in its activities is produced by the oxidation of its substance.

It is evident that a test may be used to diagnose faulty instruction quite as well as to determine what pupils know. If teachers would list the number of errors made on each item of a test they would readily see what items needed re-teaching. One is suspicious from the large numbers of errors made that teachers are themselves not clear on the matter of respiration in plants.

Inspiration of Science

The advance of science has tended to make us more modest. Man obviously does not hold as significant a position in the universe as he once supposed. Though his knowledge grows from day to day and is capable, in a measure, of verification, it is fragmentary, relative, and subject to constant revision. Dogmatism is out of place, loud affirmation not permissible.

The method of science, proceeding by induction and deduction, circumspectly, warily and tentatively, from the less to the more adequately known, is at once the most revolutionary element and the greatest agency for fostering humility and modesty. The boundless space, the infinite stretches of time, the exhaustless energy, the orderliness of all the processes of nature, the unexplored beyond in every direction cannot fail to inspire a sense of awe and mystery and reverence.

The wonders accomplished by the scientific technique, far more impressive than all the miracles he dreamed of in his youth, have revealed that there is in his nature a vast fund of creative ability. He can change his material and social environment; he can change himself; he can change the heredity and environment of posterity.—*Nathaniel Schmidt in "World Unity."*

The Grand Rapids Nature and Science Course of Study*

Helen K. Mackintosh
Supervisor Later Elementary Grades
Grand Rapids, Michigan

When a review is made of elementary school experiences in the field of nature study and science of twenty-five years ago, the only thing that comes to mind is this quotation:

"The earth is a hoary old volume,
Its pages are layers of stone,
And on it in letters of fossil
The tale of the ages is strown.
To read it, we gather the fossil
And mark where the Saurian trod,
We bind them with patience together,
The hieroglyphics of God."

The opportunities which girls and boys of today have for meeting nature at first hand stand out in contrast to the situation presented above in which the child met the experience second hand with no concrete materials or examples to make her see and think and feel, in addition to memorizing.

In Grand Rapids, curriculum construction has been under way for the past five years. A brief description of its development and the organization of material is presented here. Since the writer's contacts have been especially with the work in grades 3-6 inclusive, during the past two years and a half, this paper will deal with those particular grades in some detail. Under the direction of Dr. George C. Kyte of the University of Michigan, and following a course in curriculum construction, given in 1926-27, committees of teachers and principals developed tentative courses of study for each subject matter field, which have been in use in our schools since the fall of 1928. The courses were developed on the basis of best practice as represented in courses of study, upon available scientific investigations, and upon present practice in our schools. The courses are somewhat voluminous, but teacher appraisal during the period of trial will result in a more condensed curriculum when revision takes place.

Each course is organized on the same plan in order to make

* Presented at the meeting of the National Council of Supervisors of Elementary Science, Atlantic City, February, 1930.

the curriculum most usable to the teacher. If one opens the Nature Study and Science Course of Study there are first of all the General Aims of Education which include Citizenship, Leisure, Home, Vocation, Health and Character. These are followed by General Aims for Nature Study and Science, which are classified under the same headings as the General Aims of Education. Next, a section entitled Procedure gives a bird's-eye view of the grade placement of material for grades four, five and six together with suggestions on methods to be used. The grade outline for each grade follows immediately upon this general section. The content for each grade is preceded by a type lesson or type unit which serves as an example of excellent work carried on somewhere in our own city. This type unit is so organized that the following points are indicated: How the Activity Arose, Materials Used and Subject Matter Involved, Activities Carried On, Learning Digressions, and Outcomes. Instead of a logical outline of subject matter to be covered in each grade, the plan of Suggested Activities followed by Outcomes, has been used. The word "suggested" has been used advisably, since the point has been stressed that any worthwhile activity which can result in the outcomes listed, may also be used. The important thing is not the course of study itself, but the stimulation which teachers and children may receive from it in working out their own worthwhile activities, provided that the specific aims and the outcomes are kept in mind. The outcomes are expressed as Knowledges, Habits and Skills, Attitudes and Appreciations.

At this point it seems desirable to give several examples of how all of these factors listed tie up in order to make a functioning course of study. The type unit will first be presented and then analyzed:

A Study of Pond Life

HOW THE ACTIVITY AROSE—The children had read a story on how to make an aquarium. The teacher stimulated them to further interest by taking them on an excursion to a nearby pond, and to a creek.

MATERIALS USED AND SUBJECT MATTER INVOLVED — The specimens brought back from the excursion were added to by further excursions on the part of children. Materials were brought from home to assist in the making of an aquarium,

first in a tub, then in a glass table aquarium, and last of all in a metal-lined sand table. Their collection included snails, minnows, pollywogs, crayfish, sticklebacks, a frog and other occasional specimens. Pond life was then studied by directed observation and by use of reference materials.

ACTIVITIES CARRIED ON — These included excursions to pond and creek, stocking the aquarium, caring for specimens, developing work sheets, observing specimens, making portfolios and panels, and reading nature poems.

LEARNING DIGRESSIONS — The children gave an assembly, entertained two groups from other schools, helped the kindergarten make an aquarium, entertained parents at an evening meeting, gave a luncheon for their mothers where they explained their nature work as part of the program, and moreover, did wide reading in which work-type skills and abilities were emphasized.

OUTCOMES—The outcomes from this unit of work were evident in increased knowledge of nature, appreciation of nature's adaptations, increased skill in artistic expression of nature content, appreciation of nature poetry, and improved reading skills.

If this unit of work is traced through from Aims to Outcomes the following points are significant. In the General Aims under Vocation we find the statement, "By providing for effective and economical learning in a situation which grips the learner,—which is to him worthwhile." Under the aims for nature study is listed, "By acquainting the child with his environment through direct observation of man, plant life, animal life, physical phenomena, etc." Under Suggested Activities occurs the "Learning to care for animals that are brought to school, such as snakes, amphibians, etc.," and under Outcomes "Habits of close observation and comparison, and the ability to organize material, cultivated through caring for and protecting animal life." It is easily observed that the unit on pond life compares very favorably with the provisions for such a unit in the course of study.

As a second example, a unit on the study of weather will be briefly described and analyzed.

HOW THE ACTIVITY AROSE—Following several disasters on Lake Michigan, one boy brought a piece of the wreckage from

the *Andaste*. Teacher and pupils discussed the reasons for the wreck, emphasizing effect of weather on navigation. It was suggested that the 6A group visit the local weather bureau for further information.

MATERIALS USED AND SUBJECT MATTER INVOLVED — The materials included weather maps from Chicago and local stations, paper, lumber, chemicals, wood, and most important of all, reference books. The subject matter emphasized forms of water, sun behavior, star observation, and wind as factors affecting weather.

ACTIVITIES CARRIED ON—The children in 6A made a trip to the weather bureau; prepared charts on weather observation, temperature, star observation and sun behavior; asked for and heard lectures from the museum, prepared work sheets for reading maps, constructed weather instruments, organized an exhibit, and learned to forecast the weather.

LEARNING DIGRESSIONS — In the various subject matter fields there were interesting relationships for this nature study unit. In Geography, study was made of wind systems; in English letter writing and oral reports were featured; history brought in the astronomy of ancient peoples; in spelling children made contact with words such as "isobar" and "velocity"; in the construction of the weather instruments arithmetic was used.

OUTCOMES—As a result of this study children gained a knowledge of the various forms of water, causes of winds, direction from which storms come, effect of Great Lakes upon climate, barometric pressure, and work of the weather bureau; ability to observe natural phenomena and make deductions, and some skill in using weather instruments; appreciation of the effect weather has on human activity, and interest in observation and investigation.

Again, if we trace the relationship of this unit of work to the course of study, we find the following to be true. The General Aims of Education yield the following statement: "By giving such an education as will fit into child life growing into adult life." "The curriculum should be built around the interests, needs, and activities of children, as well as the directive influence of experience and contemporary society."

The aims for nature study include two that are closely related: "By developing life-long interests, attitudes, appreciations, habits and mental alertness in the presence of innumerable forms of nature" and "By fostering a disposition toward experimentation, investigation, discovery, and invention in the field of nature and science." The suggested activities listed for this grade indicate "Discuss the effect of various kinds of weather upon radio reception" and "Construct a Windrows Weather Record." The Outcomes listed are "Knowledge that some weather changes occur because the wind changes and that the wind changes are due to the passage across the country from west to east of great whirlwinds. Knowledge of the direction of prevailing winds in the different zones. Knowledge of the importance of the study of the wind in the development of aviation. An attitude of understanding toward natural phenomena."

A comparison of this unit of work with suggestions in the course of study shows that teachers and pupils approached the unit from a different point of view than the one suggested and that in so far as activities and outcomes are concerned, pupils and teacher explored and pioneered for themselves in this field.

In a similar fashion one might analyze the activity in which children experimented with two white rats, Hans and Fritz. These children were in an Open Air Room and most of them were underweight. They represented grades 3-6 inclusive. After they had built comfortable cages for the rats according to specifications which they had worked out from observation and reading, the teacher suggested that when the children were weighed, it might be interesting to weigh Hans and Fritz. Since the teacher was attempting to stress a vitamin diet with the children in order to bring them up to weight, the group decided that they would put Fritz who weighed only five ounces, on a vitamin diet and Hans who weighed seven ounces, on a non-vitamin diet. Each week when the nurse weighed the children, Hans and Fritz were weighed and the gains or losses recorded. This experiment continued over a period of three week's time. Then since their conclusion was that Hans had lost weight, was nervous, bit the children, fur turned yellow and shaggy, and his eyes bulged, while Fritz gained, was very playful, kept his fur clean, and his eyes were bright,

they reversed the diet, with the same general result as before, but Hans gained and Fritz lost. Then both rats were placed on a vitamin diet again.

These children had learned one of the rules of health and at the same time had observed animal life in relation to environment in addition to having been given experience in caring for animals. Further examples might be listed and discussed in the process of showing that the course of study functions most adequately when it stimulates a group to go beyond what is asked for and allows them to adapt their experience to their needs and interests.

To sum up the discussion thus far, the development and organization of the course of study for grades four, five and six has been presented. The course for grade three is in the process of a first revision, which will put it into the same form as the fourth, fifth and sixth grade material. The kindergarten-first grade course has been available in revised form for the past two years. It is included in the content of Volume II. This course differs from the course for the later elementary grades chiefly in its parallel column form of arrangement of material on the page. The second grade course is being revised to conform to kindergarten-first grade. Although the same content is found at different grade levels, the method of approach to be used is different. Seed dispersal may be studied in grade one in such a way that the various *methods* of scattering are noted. In grade four this study may take the form of study of soil conditions as affecting seed dispersal. In grade six the study concerns itself with the habitat and control of ten common weeds.

Following this discussion of development and organization of the courses for the different grade levels something should be said with regard to the factors relating to the actual teaching of nature study. These include, the qualifications of the teacher, the relation of the content to the work of the grade, the use of work sheets as an instructional device, and other aids to the improvement of teaching and learning conditions.

The point of view presented to teachers has been that the course of study is to serve as a guide and is not to be devoured at one sitting. This is a necessary precaution since otherwise, classroom teachers are apt to become overwhelmed by the amount of material they must become acquainted with.

The classroom teacher is the teacher of nature study and science. She has no special training or preparation unless she has recently come from the normal school or unless nature is her hobby. Therefore, she deserves credit for fine accomplishment.

The recommendation is that the teacher will attempt to relate as much of her work as possible to some large unit which is in progress in her room, whenever it is feasible. However, nature study is never to be dragged in by the heels. If it does not fit into the unit which the class is working upon, it deserves a separate place for itself. An activity such as making plaster casts of animal tracks, or making a Nature Trail through John Ball Park fits in exceptionally well when youngsters are studying Michigan and Grand Rapids, in grade four. On the other hand, a detailed study of insect life, which includes observation of an ant hill placed on an ant moat, and the making of insect slides for a stereopticon lecture does not relate to the study of ancient peoples and the geography of Europe. Therefore, it deserves a place of its own in the sun.

The use of work sheets perhaps initiated by the teacher and later developed by teacher and pupils working together, groups of pupils or individual pupils, aids the child in looking for something specific as he reads or as he observes. The following is an example of a work sheet:

Follow-up Lesson on the Snail

This work sheet was made in a class period following the observation lesson on the snail. The questions were all asked by the children.

1. How does the snail grow?
2. Does a snail always stay in his shell?
3. What is the real name of the sticky substance a snail leaves behind him?
4. How long does a snail live?
5. What is the difference between common snails and water snails?
6. What do snails eat? How do they do it?
7. What happens if a snail loses his eyes?
8. How does a snail move?
9. Does a snail hear? If so, how does he do it?
10. What happens if a snail loses his shell?
11. How far can a snail go in an hour?
12. Do snails lay eggs or how are the young born?
13. Where do snails live?

Pupils are encouraged to bring in nature materials which are made use of by interrupting the larger unit for a day's time, or by furnishing an individual report in language for the child who brought the material. I am thinking in this connection of a backward child in grade three who had not had many opportunities to succeed in his group. He brought in a simple puzzle on names of birds, having had a suggestion from similar puzzles based on other material than nature. His enthusiasm and interest led him to develop a hobby that was contagious and became a leisure-time activity for many of his classmates.

Emphasis is placed upon the taking of excursions to furnish material or to arouse interest. The specific example is again taken from a third grade. The teacher aroused interest in her boys and girls for a permanent bird feeding station and shelter. Their schoolroom opened upon a court and gave no opportunity for observation. After reading a number of reference materials, a committee was appointed to select a suitable place. They chose a place about two blocks from the school, which had been recently made into a city park. This situation made it necessary for the children to consult the park commissioner, for permission to carry out their project which brought about some desirable written language work. The children were allowed to build a shelter which was improved by the use of ten Christmas trees. A feed box was put on an iron pole and made to turn with the wind. Soap trays fastened to a board and put on trees were used as suet containers. Twice a week children made food contributions. Daily visits were made possible by grouping the children into sections or committees. Reports were made on the bird visitors to the feeding station. While this activity was being carried on, children developed the habit of making trips in the interests of nature.

Experimentation as a basis for drawing conclusions is also encouraged. A group of fourth grade children studying about the world, were aided in drawing conclusions with regard to the poles, use of the compass, etc., through experiences with magnets.

Equipment is at a minimum, although a small yearly fund allows for the purchase of aquaria, dissecting microscopes,

reading glasses, pictures, and blue print paper. Materials for construction work for bird houses, anomometers, and animal cages are available through the manual training or practical arts departments.

This year as a means of stimulating further interest in nature study and science eight of our elementary school groups have chosen that subject for special study. Small group conferences with the supervisor, plus occasional conferences with teachers from the other schools who are working on the same problem have been held. Toward the close of the school year each of these groups plans an exhibit of the nature and science work carried on, as a means of arousing further interest in the city at large in the more intensive use of our course in nature study and science.

As additional aids should be listed the many mounted specimens and pictures as well as vivaria which are available from the Kent Scientific Museum. A full-time person on the staff of the museum is available for lectures, trips or other types of service which will contribute to nature and science. The moving picture program for the schools has also been planned with reference to nature study and science. Some of the titles used are:

The Sky.
The Earth.
How Living Creatures Find a Home on the Earth.
Seaside Friends and Their Country Cousins.
Down at Our Pond.
The Four Seasons.
Michigan Mammals.
"Wild Wings" (Michigan Bird Life).

To review the points which the writer has attempted to make with respect to the Grand Rapids Course of Study in Nature Study and Science, the development and organization of the course have been such that the present material is tentative and it is to be hoped that it will undergo a constant process of change through use by interested teachers and pupils. It has been urged upon teachers that the big aims of education be interpreted to children in terms of specific aims of Nature Study and Science; that children may not only know and enjoy, appreciate and desire, but that they may also be stimulated to thoughtful working out of nature's laws through

directed observations and the skillful use of authentic reference materials. Such an approach to this important elementary school field should contribute to citizenship, wise use of leisure, worthy home membership, choice of a vocation, health, and character which are the cardinal objectives for an elementary school education.

High Land in the United States

Colorado is the highest State in the Union, its average altitude above sea level being 6,800 feet, according to the Geological Survey, of the Interior Department. Wyoming is a close second, with an average altitude of 6,700 feet.

The highest point in the United States is Mount Whitney, California—14,496 feet—which is 76 feet higher than Mount Elbert, Colorado, the second highest mountain.

The highest pass in the United States is Whitney Pass, California. 13,335 feet above sea level.

The highest mountain of the Appalachian system is Mount Mitchell, N. C., 6,711 feet above sea level. Clingman's Dome, Tennessee, with an altitude of 6,644 feet, is a close second. The average height of land in North Carolina is only 700 feet; that of Tennessee is 900 feet. Every State west of the Mississippi River, except Missouri, Arkansas, and Louisiana, has a greater average altitude than these, and Colorado's average is higher than the highest point of the Appalachian Mountains.

Mount McKinley, Alaska, is higher than the loftiest peak in the United States, Mount Whitney, would be if the highest peak in the Adirondacks, Mount Marcy, were piled on top of it. Mount McKinley, according to the Geological Survey, Department of the Interior, is 20,300 feet above sea level; the combined height of Mount Whitney and Mount Marcy is 19,480 feet.

If on top of Mount Whitney, California, were piled Mount Mitchell, the highest eastern peak, the total altitude—21,207 feet above sea level—would be only a little in excess of that of Mount McKinley, Alaska. The height of Mount McKinley is 20,300 feet.

Home Made Apparatus for the Physics Class

G. H. Hyde
Superintendent of Schools
White Lake, S. D.

The physics teacher in the small school is faced with a problem that the instructor in the larger school is seldom called to meet. I refer to the problem of demonstration and laboratory equipment. The small school is limited by lack of funds and consequently by deficient equipment. It is a handicap, however, that can be overcome or considerably lessened by the ingenious or imitative teacher.

It is a delight to have fine apparatus available. It is satisfying to achieve highly accurate results. I wonder, however, whether it is the fine apparatus or the highly accurate results that remain in the minds of the pupils. Is it not the general result that we want to impress, and is it not true that it is the general result that is most often retained? Accuracy, of course, is to be desired, particularly from a habit-forming point of view, and in work where extreme accuracy is necessary we may have to fall back on the commercial equipment. Again, cannot we have accuracy within broader limits?

Vision is the great road to memory, and "do it yourself" is the best vehicle. I am firmly of the opinion that my students will reach our objectives over the desired road by our "fliver vehicles," with as much pleasure as that derived from the use of finer means of progress.

The average instructor has ample opportunity to use simple apparatus, and he has ample opportunity to construct it in his own laboratory or shop. He can build apparatus that will be entirely satisfactory as a substitute for some of the costly apparatus of the supply houses. I offer for your approval apparatus which would represent a bill considerably over $100.00, if it were to be purchased through usual channels, yet costs but a fraction of that when the instructor's time is not considered.

The greatest difficulty in this work is to get started. No instructor can successfully construct apparatus without certain

basic raw materials. I would suggest the following. Add your own ideas and it will be a good beginning.

¼-lb. spools of sizes 18, 22 and 28, D. C. C. copper wire.
⅛-lb. spool of size 20 or 22 D. C. C. German silver wire.
Small spools of sizes 18 and 22 brass wire.
Some piano wire (possibly from a wrecked piano).
Assorted glass tubing in sizes and amounts as follows:
⅛-in. ½ lb.; ¼-in. ½ lb.; ⅜-in. 1 lb.; ½-in. 1 lb.
Assorted rubber tubing to match the glass tubing.
(Glass sizes are outside sizes. Rubber tubing is quoted inside measurement.)
2 or 3 lbs. Assorted Rubber stoppers—solid, one-holed and two-holed.
½ dozen Thistle tubes, small size.
3 Glass funnels, 3-inch diameter.
6 250cc, 500cc beakers.
6 150cc, 500cc, flat-bottom flasks.
3 500cc Distilling flasks.
2 doz. 4-in. and 6-in. test tubes.
4 Burette clamps.
6 Iron clamp holders.
6 Ring stands.
6 3-in.—4-in. Ring clamps.
4 Hofmann's clamps (for closing rubber tubing).
6 glass T-tubes.
1 sq. ft. Lead sheet, 1/32-in. thick. (B. and S. No. 20.)
1 sq. ft. Copper sheet, B. and S. No. 20.
1 sq. ft. Zinc sheet, B. and S. No. 20.
1 m. Brass strips (for Wheatstone bridge).
2 doz. Binding posts.
3 each Iron, steel, and lead balls, drilled.
Alcohol stoves, small type.
1 spool Stovepipe wire.

A manual training shop is a big aid, but any school should have a small vise, hammer, saw, plane, brace and bits, tin snips, files and pliers. Packing boxes will furnish considerable lumber and the local lumber yard will furnish the rest. A sharp pair of eyes for odds and ends will yield highly. It might be mentioned that flasks and beakers common to the chemistry laboratory are very useful and serve a multitude of purposes.

Common sense will tell us that there is a great deal of apparatus we must buy. I acknowledge the services of the apparatus companies and appreciate them, but I can look in their catalogs and duplicate some of their "stuff" at consider-

able discount. They also provide simple accessories at small cost. I have noticed that binding posts and copper wire can be purchased through the wholesale radio dealers at considerable saving. Shopping around pays. Try the ten-cent stores for various articles.

I am listing some of the articles that we have constructed and the comparative costs. Details of construction are also given. In many instances they may be varied.

ARTICLE	CATALOG COST	MY COST
Boyle's Law Apparatus	$9.00	$1.50
Wheatstone bridge	6.00	1.00
Demonstration vernier	2.50	.10
Three horse evener and double-tree	4.50	.15
Surface Tension Apparatus	1.25	.05
Hand Rotator	9.00	.00
Centrifugal Force Apparatus—Globe	5.00	.35
" " " Governor	4.50	.50
Hooke's Law Apparatus	1.50	.15
Inclined Plane	2.25	1.00
Capillary plates	.30	.00
Pendulum support	1.25	1.00
Inertia ball	1.00	.00
Barometer tubes	.50	.25
Induction coil	12.00	1.50
Contracting helix	2.75	.10
Ampere's Rule Apparatus	3.50	.20
Helix, through cardboard	2.00 (?)	.20
Spark gap	2.00 (?)	.25
Telegraph key	1.35	.12
Liquid pressure gauge	1.35	.12
Cartesian diver	.40	.05
Heat shields	2.00	.15
Resistance coils	4.50	.50
Refraction tube	.50	.01
Leaning tower	1.75	.00
Demonstration siphon	6.00 (?)	.25
Composition of force board	3.00	.25
Conductivity tester	4.50	.85
Electro-magnet	1.00	.05
Mercury cup, circular central pit	2.00	.15
Pin-hole camera	2.00	.05
Dew-point apparatus	1.00	.10

Many other articles will suggest themselves after one starts to work. Some that could be named are sonometer, tangent galvanometer, electric pendulum, convection apparatus, radio

set, multiple image box, Pascal's law apparatus, intensity of light screen, third-class lever, pulleys, beam balance, center of gravity apparatus, telegraph sounder, and photometer. A number of these articles have been made by students as project work.

Construction Directions

BOYLE'S LAW APPARATUS (Illustration 1). Material—base board, 1″ x 7½″ x 7½″; upright supporting board—⅜″ x 4″ x 40″; 2 pieces of board, each ⅜″ x 1″ x 20″; 2 glass tubes, each 5/16″ x 24″; 1 rubber tube ¼″ x 28″ (thick wall); short piece of rubber tubing ¼″; 1 Hoffman clamp; piece of quarter-round, 8″ long; strips of tin, such as sometimes come around packing boxes; 2 screw eyes; 2 blocks, each ⅜″ x 1″ x 1″; a meter stick; 2 doz. ¼″ flat-head screws.

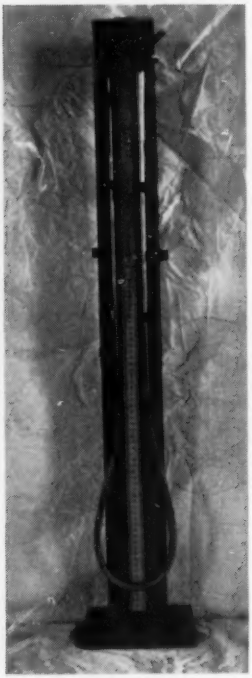

Fig. 1

Mount the meter stick in the center of the upright, with 100 cm. mark flush with one end of the board. Slip the rubber tubes over the ends of the glass tubes and lay one tube on each side of the meter stick. Lay the narrow wood strips outside of the tubes. If they extend over the edge of the supporting board, trim them to fit. Bend pieces of the tin strip around the glass tubes and mount them on the wood strips. Use other tin strips to form clips to hold the mounted tubes against the supporting board. This permits the tubes to be raised or lowered by sliding the strips up or down. It is convenient to make the last mentioned clips like a slingshot. This gives more strength from a weak material. Slipping may be prevented by putting a small block under the clip on the back side and drilling a hole through the clip and block that will permit a common screw eye to be set into the upright support. A screw clamp on a short rubber tube slipped over the upper end of one glass tube will

serve as a means of cutting off outside air. It must be a screw clamp. The glass tubes are connected by the long rubber tube, and mounted on the upright support. Cut the quarter round into two 4″ pieces and mount them on the base to form a slot into which the upright support will fit. Mercury may be poured into the open tube by means of a thistle tube or small funnel.

WHEATSTONE BRIDGE. Material: board, 1″ x 4″ x 41½″; 1 brass strip, ⅛″ x ½″ x 2½″; 1 meter stick; about 1.1 meters German silver wire, No. 20, or No. 22; 7 binding posts; 1 doz. ¾″ screws or short nails. Mount the meter stick on one side of the base board. Drill holes, that will take the binding posts, at the ends of the brass strips and one in the exact center of the long strip. Drill other holes to be used in mounting the strips. Mount the binding posts. Mount the two short strips of brass at the ends of the base with a binding post of each centered and touching the end of the meter stick. Mount the long brass strip midway of the side opposite from the meter stick. Stretch the German silver wire between the binding posts at the end of the meter stick. A galvanometer is connected between the middle binding post of the long brass strip and a sliding wire which makes contact with the German silver wire by manipulation of the operator.

DEMONSTRATION VERNIER (Figure 2a and 3). Material: wood strips, A—1½ cm. x 1½ cm. x 50½ cm., B—1½ cm. x 3½ cm. x 50½ cm., C — 1½ cm. x 2 cm. x 20 cm. Mount A along the edge of wide side of B. On upper side of A mark off 2 cm. spaces, using a sharp knife to set the mark in the wood. Make each fifth line longer than the units line. Give each tenth line a value in sequence to last tenth mark (5–6–7– or the like). The scale represents mm.'s drawn on a scale of 20–1. On C, starting 1 cm. from one end, on the 2 cm. surface, and adjacent to the marks on the large scale, mark off a vernier scale, showing and numbering marks 0 to 10. These spaces will be 1.8 cm. in order to conform to the other scale. Make the 0, 5, and 10 marks longer than the others. Slide the vernier, C, on AB in the space provided.

THREE HORSE EVENER, DOUBLE TREE, ETC. (Illustration 3(a)). The three horse evener is easily constructed by anyone familiar with the laws of levers. Use heavy wire or

strips of tin, with stove bolts of appropriate size, for clevices. It is a good idea to drill holes an inch apart the full length of the evener, thus to show the different forces required to get the "evener" effect. A piece of meter stick, or yard stick could be handily used for this purpose.

COHESION FIGURES (Illustration 3(b)). Cohesion figures showing surface tension and cohesion can be easily made from light iron wire of light gauge, like stove-pipe wire. Various forms can be made, although the cube, rectangle and circle are most common. Maybe a student would like to make the outline of an automobile and then use the soap film to cover the body.

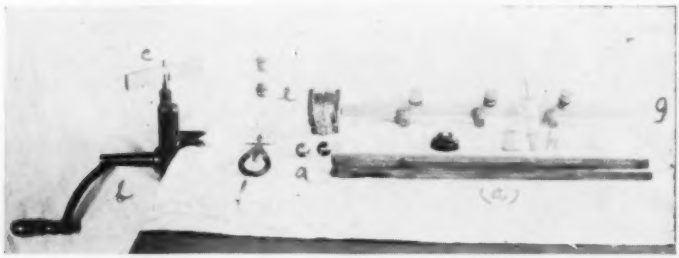

Fig. 2

HAND ROTATOR (Illustration 2(b)). This is not exactly hand made. It is the rotator part of an old Babcock milk tester, picked up locally. Means of fastening different apparatus to it have been devised.

COLORED DISCS AND SIREN DISCS MOUNTING (Illustration 2c, also 3). A thin stick about 6½ inches long is made to fit upon the notched end of the rotator shaft. An upward projection at the center of the stick fits the hole at the center of the disc, holding it in place, while the weight of the discs will cause them to cling to the support as it rotates.

A GOVERNOR (Illustration 2(d)). A governor may be demonstrated by tieing iron balls of equal weight at the ends of a stout 12-inch cord. Loop the center of the string about the slot in the rotator shaft. A changing rate of rotation will cause the balls to rise or fall.

CENTRIFUGAL FORCE (Figure 2e and 3). Centrifugal force may be shown by using a 500 cc. flask partially filled with

mercury and colored water. For mounting on the milk tester rotator it was necessary to cut a two-hole rubber stopper that fitted the flask, so that it would fit on the end of the rotator shaft. A solid rubber stopper was strung on a string and pushed down in the neck of the flask so as to seal in the liquids when the flask is inverted (a strong string is used to pull out the stopper). Invert the flask and push it down on the stopper which is mounted on the rotator. At advanced speeds the flask tends to wobble. This can be overcome by cutting a blackboard eraser in two, take out the middle sections, and fit the two halves around the neck of the flask as a collar, which can be steadied by one hand. This works very well and duplicates the work of a $5.00 piece of apparatus.

CENTRIFUGAL FORCE AND GRAVITY (Illustration 2(f)). Centrifugal force as it opposes gravity and might oppose it is easily shown by a ten-cent store product. A small horseshoe magnet using a little tin man as an armature was procured. What makes a better illustration of gravity than a little man sitting on the magnet as it revolves, and what happens to the influence of gravity when an increasing centrifugal force tosses the little man off into "the void?"

CENTRIFUGAL FORCE APPARATUS. A weight fastened to a strong rubber band, which may be swung about the hand, shows the influence of centrifugal force by stretching the band further at increased speeds. It is well to have a life line in the shape of a length of string fastened to the weight and held in the hand to stop the flight of the weight in case the band breaks.

HOOKE'S LAW APPARATUS (Illustration 3(c)). Material: Ringstand; meter stick; meterstick clamp; ring or burette clamp; spool of No. 18 or No. 22 brass wire. Release wire from the spool. It will partially uncoil. Cut off the length of coil necessary to make a satisfactory spring. (Further winding is not necessary.) Make a loop in the wire at one end so it may be hung up and at the other end bend the wire to form a pointer, with a small inverted hump below the center of the coil to which a scale pan or hooked weights may be fastened. Mount the meter stick on the ring-stand and hang the spring from the ring or burette clamp so that the pointer will follow the scale of the meter stick as a measuring scale for determining the strain, or elongation.

INCLINED PLANE. Purchase a regular inclined plane pulley from any supply house. Mount it on a smooth board 1″ x 4″ and about four feet long. A rod held between two ring stands will make a good support. It will be necessary to block the lower end to keep it from slipping.

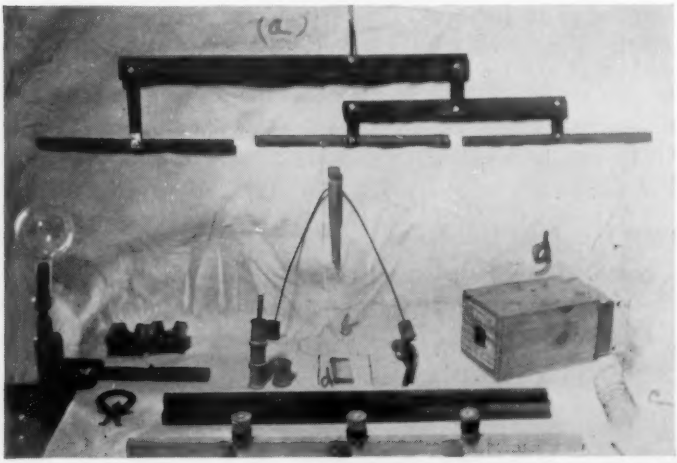

FIG. 3

CAPILLARY PLATES (Illustration 3(d)). Obtain two common microscope slides. Place a rubber band lengthways and to one edge of one of them. Place the second slide against the first and hold by means of rubber bands. When placed on end in shallow water the narrowing space between the plates shows capillarity nicely.

PENDULUM SUPPORT (Illustration 2 (g) also 3). Material: stick, approximately ¾″ x 1″ x 22″; three ordinary spools; three 1″ corks; ¼″ dowell pins; thread. On the narrow side of the stick and at three points equidistant from each other, drill ¼″ holes, and set dowell pins, or pins whittled to fit. On one spool wind 3 meters of thread, on another 2 meters, and on another 1 meter of thread. Mount the corks on the wide side of the stick just to one side of the dowell pins. Slip a spool over each pin and catch the thread between a cork and the stick, or in a slit cut in the cork. When a pendulum weight

is hung on a thread the friction between cork and stick will retain the thread at any desired point.

INERTIA BALL. Any heavy weight may be used for this purpose by tieing a wire about it to which threads may be attached.

BAROMETER TUBES. Take different lengths of ¼″ glass tubing, such as 15″, 25″ and 35″, and seal one end of each tube. When filled with mercury and inverted in a mercury cup they illustrate the barometer and the principles governing it very nicely.

LEANING TOWER (Illustration 2(h) or 3(h)). Slide a number of spools over a central shaft. Saw the bottom spool at a slight angle, so that the tower will stand when the upper spool is removed, but will fall when it is in place.

PIN-HOLE CAMERA (Illustration 3(g)). Material: 2 chalk boxes; sheet onion skin paper; paraffin; thumb tacks. Take the ends out of one of the boxes and tack on the cover. Fasten one thickness of onion skin paper over one end by means of the thumb tacks. Paint the paper with melted paraffin and scrape off the surplus when it has cooled. Cut the second box down so that it will slide within the first. Take out one end. In the center of the remaining end drill a ¼″ hole. Paste a small piece of paper over this hole and then puncture it with a small divider point, or a pin. Trial may demand that it be enlarged. Slip the second box inside the first. Point the small opening toward any object that is fairly well illuminated and the image will appear on the paraffin screen. It aids in getting a clear picture if a hood is made for the screen.

INDUCTION COIL (Illustration 4(a)). Get one of the old-type Ford coils. From an old radio battery get three Fahnstock binding posts. Solder the binding posts to the contact points of the coil and indicate primary and secondary connections. This makes a very satisfactory induction coil for laboratory use. It can be used in a radio sending set without trouble.

CONTRACTING HELIX. Wind No. 22 or No. 24 D.C.C. copper wire on a rod of approximately one inch diameter, so that the resulting helix is 10-12 inches long when hung by one end. Bend the tip of the wire at one end so that it will make contact with mercury in a cup, or small container below. Con-

nect a battery to the upper end of wire which is suspended from ring stand, and to the mercury cup. Adjust the contact of the coil with the mercury so that contraction of the coil will break the circuit.

AMPERE'S RULE APPARATUS (Illustration 4(b)). Wind 6-8 turns of No. 22 D.C.C. copper wire so as to form a rectangle of convenient size, such as 4″ x 6″. Mount the rectangle on a base board and connect the ends of the wire to binding posts. Cut a cardboard and mount it horizontally across the coil. The cardboard will support iron filings or compasses used in showing the magnetic field about a conductor.

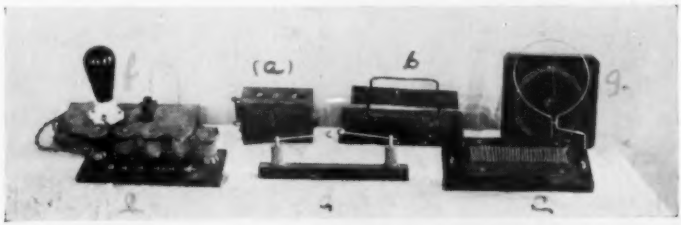

Fig. 4

HELIX THROUGH CARDBOARD (Illustration 4(c)). On a piece of cardboard about 4″ x 10″ mark out a rectangle the size of the helix that is to be threaded through the card. On the sides of this rectangle, with a draftsman's dividers, or a ruler, set off the points where the helix will pass through the card. It is a good idea to offset the points on one side so that they will fall between the points on the other side. These points should be from ½″ to 1″ apart. The next task is to thread the wire through the card and at the same time keep the succeeding coils circular. Punch holes through the card at the points marked, large enough for the wire to pass through. Use round or half round sticks on either side of the cardboard and wind the coil around them. The wire can then be pulled up without fear of cutting the cardboard, or of having coils of irregular size. Mount the card when threaded on a base by means of blocks at either side. Leave the ends open so that an iron core may be placed in the helix below the cardboard. Fasten the ends of the wire to binding posts. When the wire is connected to a dry cell, and iron filings are scat-

tered over the card, it shows the magnetic field nicely. By adding an iron core beneath the cardboard the field will be concentrated. Compasses placed along the card or between coils will show how the field runs.

SPARK GAP (Illustration 4(d)). A spark gap taken from an old static machine was used. Spools fastened to a wooden base were used as supports. Copper tubing was driven into the spools and the standards of the discharging balls were set down in them. It made a snug fit. Wires could be soldered to the base of the tubing and run to binding posts as points of contact. Small battery clips could also be snapped to the discharge *arms* for contacts.

TELEGRAPH KEY AND SOUNDER. A cheap electric push button does very nicely. A sounder may be illustrated by shorting an electric buzzer.

LIQUID PRESSURE GAUGE. Take a short thistle tube with a stem about two inches, or less, long. Bend the stem at right angles to the bulb. Tie a piece of rubber dam over the mouth of the thistle tube. In another tube of the same size and about 15 inches long make a right angle at one end. Connect the thistle tube and this short arm by short rubber tube. The right angle arms permit the thistle tube to be turned to determine the pressure in any direction. Connect the long arm of the long tube to a horizontal tube in which a drop of water has been placed. Increased pressure will force the drop along the tube.

CARTESIAN DIVER. A test tube, preferably a small 4″ one, is partially filled with water and inverted in a graduate or other suitable container. The amount of water must be adjusted so that the test tube barely floats. Pressure from the hand placed over the cylinder mouth will cause the "diver" to sink. A mystifying variation is to put the "diver" in a flat, thin-walled bottle. Final floating adjustment may be made by forcing down or withdrawing the cork. Gripping the bottle will cause the diver to sink. The suggestion is generally made that it is caused to sink by rubbing the bottle with the hand, or by waving the hand in the air. If a small test tube is not available, take a three-inch piece of glass tubing and put a cork in one end. The cork will overcome the excessive weight of the thick tubing.

HEAT SHIELDS. So-called heat shields can be used for other purposes. Carhart and Chute use them in experiences in light. The two shields are identical except that one has an inch square opening at the center through which glass tubing may be passed, or over which paper may be fastened and then perforated slightly for the passage of a beam of light. The second shield is used to mount a paper upon which the image or succession of images may be traced. They may be of any size. A convenient size is to make the base 9″ x 8″ and the upright 9″ x 12″. Make the upright out of wall-board and it will be easy to set pins or thumb tacks in it.

RESISTANCE COILS — Set mounted (Illustration 4(e)). Material: 5 large spools; suitable base upon which to mount them; 6 binding posts; D.C.C. copper wire, sizes No. 22 and No. 28, 30 meters of each; No. 22 D.C.C. German silver wire, 10 meters.

Drill two holes in one end of each spool through which the ends of the wire to be mounted may be passed. This holds the wire in place. Wind 20 meters of the No. 22 copper wire on a spool, being sure to leave enough free wire at the ends so that they may be fastened to binding posts when mounted. Wind 10 meters of the No. 22 copper wire on another spool. Wind two spools with 20 meters and 10 meters of No. 28 wire. Wind the last spool with the 10 meters of No. 22 German silver wire. Set dowell pins in the base over which the spools may be slipped as mounts. It is convenient to set the binding posts on a narrow strip of thin wood or a strip from a discarded radio panel. The ends of the wires on the spools are then soldered to the binding posts in series, so that any number may be used in combination.

REFRACTION TUBE. A simple refraction tube can be made by bending a six-inch piece of glass tubing, ¼″ size is all right, until refraction occurs when one end is held to the eye and the other pointed at a source of light. Do not bend at a sharp angle, but make the bend curved. It will be about 30 degrees from a straight line.

DEMONSTRATION SIPHON (Illustration 5). Material: base block, 1″ x 3½″ x 12″; block 1″ x 1½″ x 2½″; block 1″ x 1½″ x 11½″; block 1½″ x 1½″ x 9″; heavy wire, not lighter than No. 16, 30″ long; ordinary spools, about two dozen; two

thin wood strips 1½″ wide x 10″ long; 4-½″ flat-headed screws; 4-½″ brads; piece of fine wire; 2 50-gram weights.

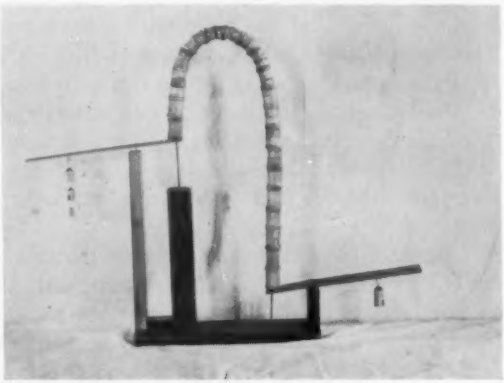

Fig. 5

Mount the 2½″ block at one end of the base and the 11½″ block at the other end. Three inches from the end of the base upon which the short block is located center and drill a hole which will snugly hold the heavy wire you use. In one end and at the center of the 9″ block, drill another hole of the same size. Mount this block so that the hole drilled is at the top and the block centers three inches from the end of the base upon which the long block is set. Saw six spools on an angle and glue them together again after turning one half on the other. This is to make them slide easier on a bent wire. Saw six more of the spools in half at right angles. Bend the heavy wire so that the ends will fit in the holes prepared and set the wire vertical to the base. Remove the wire and string the spools on it, starting at the long arm. Put on first a whole spool and then the offset spools, followed by those cut in half and then whole spools. Remount the wire.

In the center of the top, and on a line parallel to the end of the base, of each of the two end blocks set two flat-headed screws. These are to serve as pivot points. On each of the wood strips measure off 7⅛ inches from one end. Draw a line across the strip at this point and drive two ½″ brads so that their points will rest on the screw heads set in the blocks. These brads and screw heads form the fulcrum of a lever.

Cut a notch in the short arm of each lever so that the wire will pass through it and not interfere when the spools rest on the lever. Using a fifty gram weight (any other convenient weight will do) find the point on the lever supporting the longer column of spools, where the weight will just balance the weight of the spools. Care must be taken in establishing this point. Drill two holes at the point established and thread fine wire through them to make a swing to which weights may be hung. On the second lever, and at a point exactly the same distance from the fulcrum as in the other, make another weight swing.

The proof of the siphon lies in comparing the two columns of spools to columns of water. The wire represents the tube. The levers are equal and using equal weights on each give equal upward pressure on the spools. They correspond to air pressure. Since the upward pressures are equal and the columns of spools are of unequal weight, the spools will move around the wire pushing down the lever on the long side. It is absolutely necessary that the leverage on the short side exert a greater force than the weight of the spools, or it will not be able to lift them. The same is true of the air pressure on the column of water in the short arm of the siphon. If the water weighs too much the air pressure will not lift it. Also, if there is no pressure from the lever the spools will slip back down the wire, which is exactly what the water in the short arm of the siphon would do in case it were a vacuum.

COMPOSITION OF FORCE BOARD. Get a hoop from an apple or flour barrel. Set screw hooks at intervals inside its rim. These hooks offer excellent points to which spring scales may be fastened. Angles may be measured with a protractor.

CONDUCTIVITY TESTER. At a ten cent store purchase a porcelain electric light socket, enough lamp cord to reach a convenient outlet, a screw plug, and a colored light bulb. Two binding posts are also needed.

Mount the socket on a base, 4″ x 8″, two inches from one end. Set the binding posts in a discarded piece of a radio panel, 1″ x 2½″. Drill a hole in the center of this mounting and with a long screw and a half spool as a sub-mount, fasten it 3½″ from the other end of the base. A piece of No. 16 copper wire, 8″ long, is fastened to each binding post and bent so that the two wires will slip into a beaker when it is

placed on the end of the base. One binding post is connected to the socket. Fasten one wire of the lamp cord to the other binding post and one wire to the second contact of the socket. Put the screw plug on the other end of the lamp cord. Put the colored bulb in the socket. When connected in a lighting circuit the bulb will light whenever an electrolyte comes in contact with the bent wires. The colored bulb is preferable to a plain bulb because it catches the eye and makes more of an impression than does the plain.

ELECTRO MAGNET. Material: two flat-headed bolts, 1 2″ diameter, 3″ long; a yoke 3″ long, drilled at each end so that it will fit over the bolts; 4 nuts; spool of copper wire, D.C.C., size No. 22 to No. 28. Three Fahnstock binding posts from an old battery.

First turn a nut far enough down on each bolt so that room is left to put on the yoke and cap nut. Wind the space between the bolt-head and the first nut with the wire, leaving both ends of the wire free after they have been secured against unwinding. Put on the yoke and fasten it in place with the cap nuts. Connect the two ends of the wire at the yoke end of the coils by soldering an old battery clip to one wire and snapping the other wire to the clip. Solder a clip to each of the wires at the pole ends. These provide handy connections for the battery wires. The connections may also be reversed, that is, connect the two wires at the poles and use the ends at the yoke for the outside contacts. Caution: Be sure the coils are connected so that the current will pass around them in opposite directions.

MERCURY CUP, DOUBLE. Material: wood block 1½″ x 8″ x 8″; two shingle nails; short pieces of No. 22 copper wire; 2 binding posts; some paraffin (a short piece of candle). Find the center of the block and with a pair of dividers mark a three inch circle from this center. With a one inch drill sink a central "well" one inch deep. Using a ¾″ drill and a chisel cut out a circular well, using the three inch circle as a guide for the drill. The resulting wells will probably be uneven in the bottom. This can be remedied by filling in the low places with paraffin. Drive a shingle nail through the bottom of each well. Clip them off on the under side. Solder a No. 22 wire to each nail and connect them with bind-

ing posts mounted on the block. This block is used particularly in Carhart and Chute, but is excellent in any class. Its main purpose is to show the reaction of a circular conductor to magnetic influences of electric current and permanent magnet. The form of the cup permits a conductor suspended with points in the mercury to turn freely.

A handy cup can also be made by inverting a hollow glass stopper and fastening it in a burette clamp, or any method to hold it steady. Connecting wires need only be dipped in the mercury.

DEW POINT APPARATUS. The simplest apparatus uses a six inch test tube, a bent glass tube and a rubber tube a foot or two long that will fit over the glass tube. If the test tube is filled with ether, a thermometer placed in it, and then air blown through it by means of the bent tube, the reduction in temperature due to evaporation will cause moisture to collect on the test tube when the dew point is reached. A double test, the average of the temperature when moisture collects and the temperature when it disappears, gives the temperature of the dew point.

Moth Killers Effective Only In Air-Tight Space

Small cases, cards, or bags containing naphthalene or paradichlorobenzene, sometimes called P.D.B., will not furnish protection against moths when hung in a room or large closet, will not drive out flies, mosquitoes, roaches, bedbugs or ants, and will not purify the air, disinfect, or destroy odors.

"For many years these materials have been called 'moth repellants' and it was believed their odor would keep moths from entering a closet or drive them out if they were already there, but we now know that such is not the case," says Mr. Abbott, who has just concluded a number of varied experiments with these insecticides.

"Experiments have shown that moth larvæ will crawl through a line of P.D.B. or remain feeding within a few inches of several ounces of it or of naphthalene and not be affected. Adult moths will fly over P.D.B. placed across the side of a box and deposit eggs on the flannel in the box or will remain and breed in a small open room or closet where both compounds are present in considerable amounts. These experiments show that the mere presence of these materials or their odors will not repel moths or prevent moth injury.

"Both P. D. B. and naphthalene are very effective against moths when used as fumigants at the proper dosage in small, tight containers, as for example, boxes, trunks, chests, and small tight wardrobes or closets. They can not be relied upon in ordinary rooms or closets that are not tight."

The Bureau of Entomology recommends a dosage of 1 pound of P. D. B. or naphthalene to from 6 to 10 cubic feet of air space in tight containers. This we have found to be effective.

A General Science Lesson Plan

CARL H. SCHMIDT
High School, Columbus, Nebraska

The constant search for something different in the manner of presentation and some manner to meet that ever-present torment, "individual difference," was rewarded by an article in the "Journal of Chemical Education"[1] by Alyene Westall of Newtown, Illinois. The contract plan in itself is not new but the article offered several suggestions to the present writer. It has been tried with varying success with several classes in several science subjects. The lesson plan in general science offered herewith has met with more success than the rest, however. More time and care was spent in planning it, and it was used on a larger group than any previous assignment. The assignment was used with one hundred cases of freshman students in general science. Two sections were select groups, with high I. Q.'s. The other two, because of varying conflicts, could not be properly sectioned and therefore presented a wide variation in I. Q.'s (from 70 to 123 and 70 to 125).

Because the plan met with considerable success in presenting health ideas through science study, and with the hope that this study may prove of interest to other teachers of general science, it is passed on. All items in the assignment were carefully weighed by the school nurse, the principal, and the writer, because proper weighing of the items presents one of the biggest problems in the scheme. The school nurse aided in locating material, class-room talks, and in conferences with individual students.

A threatening epidemic of infantile paralysis, when three new cases were reported in the city within a week, assured interest in health study. In fact, interest and rivalry ran so high that parents had to limit the evening study hours. This rivalry, resulting in a tendency to slight other subjects, may become one of the evils of the plan unless a means of control has previously been devised.

The writer finds several objectionable features to the plan. Themes may all too often be mere copy from books and pamphlets rather than expressing student thought. The chances

1 Alyene Westall: "A Prescription for Arousing Enthusiasm in Chemistry." Jour. Chem. Educ., Sept. 1929.

for copy are great. A good bonus for original work off-sets this with some students, but not all. The plan requires much more work on the part of the teacher. Reading all the themes is a colossal task. Keeping a record of the points made presents another problem. The writer used a chart of ¼-inch cross section having student names to the left and the items, designated by their number, at the top. Each student is then credited with his points in the proper section.

	100–1	100–2	50–1	50–2	25–1	25–2	etc.
John Smith		100	35		20		
William Jones	60	125				30	
etc							

The lesson plan together with the summary of the study presented here allow the reader to draw his own conclusions. The writer wishes to suggest, however, that many of the themes turned in merit credit in English as well as in science. The same comment holds true on other departments also. Much material presented in a study of this kind should help to unify all education rather than to present the material as from so many isolated departments. A glance at the summary sheet shows that perhaps the I. Q. is not the only measurement that is needed to indicate success. Perhaps success is only ten per cent inspiration and ninety per cent perspiration after all.

SUMMARY OF RECORD[2]

Pupil Number	I. Q.	Sex	Points Earned	Final Grade	Av. Test Grade	Themes	Posters	Scrap Book	Time said to be spent outside of classroom per day
1	140	M	515	1	80.5	2	2	1	1½ hr.
2	132	M	365	2	65.5	2	2	1	1 hr.
3	151	F	685	1	93.5	2	6	0	1½ hr.
4	131	F	530	1	79.5	2	4	0	2 hr.
5	129	F	410	1	70.0	2	4	1	3 hr.
6	126	F	545	1	87.5	2	3	1	2 hr.
7	123	M	255	4	67.5	1	2	1	1¾ hr.
8	122	F	470	1	89.0	4	2	1	20-60 min.
9	121	F	690	1	90.5	0	4	1	2 hr.
10	121	F	420	2—	64.0	2	2	1	2½ hr.

2 This is a sample record of 10 pupils. Similar records were kept for all pupils. Where grades seem low for points recorded, the required laboratory work was not done. Reports, a copy of which was turned in after the report, are here classified as themes.

The writer doubts very much that the time given by the pupils is even a fair estimate in many cases.

The following is a summary showing the popularity of each item in the assignment. Eleven pupils chose the home-room program (100-1), sixty made scrapbooks (100-2) and three elected the medical advancement (100-3). Under the 50-point assignments, numbers 4, 2, 1, 5, 7, were the most popular in the order given. The least popular were 12, 9, 11, 13, 6 and 10. The most popular 25-point assignments were numbers 7, 2, 5, 1, 11, 10 and 6. The least popular were 16, 4, 14, 12, 3 and 8.

Charts and Scrapbooks

HEALTH

The Assignment Sheet

General Science. October 6 to October 22.

OBJECTIVES:

Health is the greatest gift boys and girls can receive. How to insure and to maintain health is one of the chief objectives of all education.

OUR IMMEDIATE AIM IS TO LEARN:

1. **What science has found concerning the relation of food, clothing, exercise, rest, fresh air and sunlight, and general care of the body to health.**
2. **The nature, cause, and control of disease.**

3. The effect of good and bad habits on health.
4. The effect of the use of tobacco, alcohol, and drugs on health.
5. Our privileges in, and responsibility to our community from the health standpoint.
6. Having learned these things, to present them to our school through posters, exhibits and plays.

125 POINTS TEXT ASSIGNMENT

Caldwell and Curtis: "Introduction to Science." 1929.

Chapter XXIV. "Dependent Organisms in Relation to Man." pp. 413-436
Chapter XXV. "Foods and Their Uses." pp. 437-457
Chapter XXVI. "The Human Machine." pp. 458-479

Study the above assignment very carefully. Write out the answers to the test questions at the end of each chapter assigned. (Use ink.) The answers to the questions on page 436 will be due October 9th. Those on page 457 will be due October 15th. And those on page 478 will be due on October 21st.

Three tests will be given, one over each chapter, coming on the dates, respectively, when the questions are due. An average of 70 must be made on these tests to qualify for the points or to make a grade of one.

Materials must be in on the due date to receive credit for them.

ASSIGNMENT HELPS

These references will help you find the materials that you will need to make the posters, write the themes, and make reports to the class.

Text, *Caldwell and Curtis.* Chapter XXIV.

1. Bacterial Diseases. pp. 421-434
2. Toxins and Antitoxins. pp. 424-432
3. Jenner. pp. 428-429
4. Pasteur. pp. 430-431
5. How Disease Germs are Carried. pp. 432-434
6. Flies as Germ Carriers. pp. 432-434
7. Health as a Community Problem. pp. 435-436

Text. Chapter XXV.

1. Mixed and Balanced Diets. pp. 441-457
2. Foods and Their Uses. pp. 437-457
3. Vitamins. pp. 444-446
4. Milk. pp. 446-450
5. Food Preservation. pp. 450-455

Text. Chapter XXVI.

1. Accidents to the Body. pp. 471-474

Pieper and Beauchamp: "Everyday Problems in Science." 1925.

1. Keeping in Good Physical Condition. pp. 140-170
2. Protecting Ourselves from Disease. pp. 192-225

Wood and Carpenter: "Our Environment, How We Use and Control It." 1927.

Chapter XIX.

1. Hygiene of the Blood System. pp. 571-573
2. Importance of the Teeth. pp. 573-576
3. Care of the Human Engine. pp. 576-582

Chapter XX.

1. The Nervous System. pp. 586-591
2. The Nature and Importance of Habits. pp. 591-592
3. Handicaps of the Nervous System. (Alcohol and Tobacco) pp. 592-597
4. Safety First. pp. 597-605

Chapter XXI.

1. Microorganisms and Their Work. (Bacteria and Foods) pp. 609-623

Chapter XXII.
1. Bacteria. pp. 635-645
Chapter XXIII.
1. Protecting the Community. pp. 657-672

Food Iron and the Treatment of Anemia.	Bulletin
Tonsils and Adenoids.	Metropolitan Bulletin
All About Milk.	" "
First Aid in the Home.	" "
Eyesight and Health.	" "
How to Live Long. (Health Rules)	" "
Health Heroes. (Louis Pasteur)	" "
Health Heroes. (Edw. Trudeau)	" "
Health Heroes. (Edw. Jenner)	" "
Health Heroes. (Walter Reed)	" "
Good Teeth.	" "
Foot Health.	" "
Sunlight the Health Giver,	" "
Importance of Eye Care.	Eyesight Conservation Leaflet
Glare and Its Relation to Eyesight.	" " "
Conservation	" " "
Light in the Home.	" " "
Conservation of Sight.	" " "
Food Charts.	Kellog
Health Rules.	Kellog
Nutrition and Health.	Borden's Health Lessons
Child Health.	Borden's Booklet
Boy Scout Manual.	
Johnson's First Aid Manual.	
Long Life in Children's Teeth.	Postum
Life of Theodore Roosevelt. (Book, City Library)	
A Syncopated Health Trial.	Hygeia, Oct. 1930, p. 944
What the Physician Has Done for Childhood.	Hygeia, Mar. 1930, p. 248
Nuts (food)	Hygeia, Mar. 1930, p. 253
The Signs of Tuberculosis.	Hygeia, Mar. 1930, p. 265
Epidemic Meningitis.	Hygeia, Mar. 1930, p. 235
Warm Water Healing (Infantile Paralysis)	Hygeia, Oct. 1930, p. 913
Health a la Carte (Food)	Hygeia, Sept. 1930, p. 812
Twelve Health Posters from Brazil.	Hygeia, Sept. 1930, p. 815
The Dutchess of Trent (Play)	Hygeia, Sept. 1930, p. 846
Preventing Painful Feet.	Hygeia, July, 1930, p. 631
Proper Posture	Hygeia, Nov. 1929, p. 1091
Founder of Our Knowledge of Tuberculosis (Trudeau)	Hygeia, Nov. 1929, p. 1130
Model Shoe Described.	Hygeia, Oct. 1929, p. 991
Lying Labels (Patent Medicines)	Hygeia, Feb. 1930, p. 132
What is Your School Doing to Prevent Colds.	Hygeia, Feb. 1930, p. 132
Hay-Fever and Asthma Quackery.	Hygeia, June, 1929, p. 590
Health Plays for School Children.	Bulletin
A Book with a Mission (Communicable Diseases)	Johnson & Johnson
First Aid Instruction Outline.	Johnson & Johnson

100 Points — Point Assignments

1. Prepare activities program for Home Rooms. Due Oct. 22
2. Make a scrap book covering health in general. Due Oct. 22
3. Show the advancement of medical science in the past ten years. Due Oct. 22

50 Points. Posters, Themes, or Articles for the School Paper.

1. Right living and health, results in the future years. Due Oct. 21
2. Effect of narcotics and stimulants on health. Due Oct. 20
3. Effect of exercise (or athletics) on health. Due Oct. 17
4. How diseases may be spread. Due Oct. 18
5. Vaccination and antitoxin. Due Oct. 9

6. Report to class on general symptoms of 7 common contagious diseases and their care. Due Oct. 21
7. Make a report to the class on general care in the sick room. (See the school nurse.) Due Oct. 21
8. Demonstrate to the class how to revive a fainted or drowned person. Due Oct. 20
9. Theme on the responsibility of the individual to the city in a health program. Due Oct. 10
10. Theme on the responsibility of the city to the individual to insure health. Due Oct. 10
11. Learn to know the city and state laws which are intended to safeguard health. Due Oct. 21
12. My part in the school health program. Due Oct. 10
13. Prevention vs. cure (disease or accident). Due Oct. 16
14. Keeping physically fit. Due Oct. 17
15. Importance of play in life. Due Oct. 17
16. Five good games for high school boys or girls. Due Oct. 17

25 POINTS

1. Original posters on health rules. (See Wood and Carpenter, page 580.) Due Oct. 13
2. A class report on any one: Jenner, Trudeau, Reed or Pasteur. Due Oct. 8
3. Theme on useful and harmful bacteria. Due Oct. 3
4. Special report: "Diptheria in City Last Year." (See text, page 428.) Due Oct. 16
5. Poster displaying a balanced diet. Due Oct. 13
6. Good air and health. Due Oct. 14
7. Relation of care of teeth to health. Due Oct. 20
8. Pure water and health. Due Oct. 13
9. Cleanliness and health. Due Oct. 14
10. The fly as a menace to health. Due Oct. 14
11. Sleep or rest and health. Due Oct. 15
12. Graph comparison of the absence because of illness, boys vs. girls. Due Oct. 16

50 POINTS

These 50 points will be given for doing the laboratory work and writing up the experiments in ink after the proper form.

Required experiments:

Demonstration 53, page 610, Wood and Carpenter.
Do air, water and food contain living organisms.
Experiment, page 637, Wood and Carpenter.
Flies and bacteria.
Experiment 34, page 154, Pieper and Beauchamp.
Experiment 34, page 155, Pieper and Beauchamp.

Two pupils may work together to write a playlet to be given as an assembly program. The pupils whose play is accepted will be given a one and will be exempted from the quarterly final.

You are given your choice of working out the various projects as posters, articles for the school paper, or themes, unless specifically stated otherwise.

Remember that this material is to be used in a display here in school and possibly in the grade schools. Do neat work.

Originality will be rewarded in all the work. Themes turned in for 50 points must be not less than 300 words in length. Those turned in for 25 points to be not less than 150 words in length.

To receive a *one*, you must earn 400 points; a *two*, 350 points; a *three*, 300 points; a *four*, 250 points. No credit will be given for less than 250 points. Only those passing the test with an average of 70 will be given a grade of *one*.

Two Ninth Grade Science Projects[1]

THOMAS MCCLUMPHA
Amsterdam, N. Y.

The two projects which follow have been used with success in ninth-grade classes. The addition of an artistic touch involving original work in making a notebook, having constructions in color, has proved of great value in raising the morale of the class.

MODERN HEATING—A COMPLETE STUDY.

On three mounting sheets in a colored folder paste the work called for, neatly done in ink. Decorate the folder front with a cutout from magazine or catalog of a modern heating system. Printing on cover is best done with Black India Ink.

SOURCES OF HEAT

1—Name 4 sources of heat—give a concrete example of each. (On inside of cover paste magazine cutouts which illustrate each source of heat mentioned.)

2—Make a drawing of an experiment used to prove that the kindling temperatures of various fuels differ. State the results of the experiment.

3—Define oxidation. Give 2 examples of rapid oxidation, 2 examples of slow oxidation. Name one result and 2 products of oxidation.

HOW HEAT AFFECTS MATTER

1—Make a drawing (composite) of experiments used to prove that something happens to a gas, liquid, or solid when heated. Write out the observations and conclusions of the experiments.

2—In terms of molecules explain why matter expands when heated.

3—List 7 examples of expansion caused by heat which are of importance to man. (On opposite mounting sheet paste cutouts to illustrate.

A STUDY OF FUELS

1—Name 8 common fuels.

2—Define a fuel.

3—Explain how heat is measured.

4—In terms of calories show the heat value of hard coal, soft coal, hard wood, and petroleum furnace oil.

5—Make a diagram, chart, or tree showing the many products obtained from coal. (The Barrett Co. will supply such a diagram.)

HOW HEAT TRAVELS. (One sheet for each question.)

1—Conduction—Under a picture of a silver spoon explain how heat travels by conduction. Make a table showing 5 good conductors and 5 poor conductors of heat, with their uses as such.

2—Radiation—Under a picture of sunlight, fireplace, or radiator, explain how heat travels by radiation. What kind of materials absorb and radiate heat best? Why is the upper air not heated by the sun?

3—Convection—Under a picture of a hot-water system or other device using a convection current of air or water, explain how heat travels by convection. Explain how a convection current gets started.

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1 It will be found that a variety of textbooks may be used to advantage. Often the teacher will need to help with information and suggestions.

OUR RELATION TO THE UNIVERSE

In each case make drawings on separate sheets. After correction, rewrite all answers in ink. Fasten all sheets together between two sheets of colored mounting paper slightly larger than the paper used for the work. Decorate top sheet with astronomical drawing or cutout.

THE SOLAR SYSTEM

1—Make a drawing of the complete solar system. Use crayons to color

2—Explain the solar system as follows:

a—State the size, importance, and nature of the sun.

b—Explain how the planets differ from the sun, compare them with the earth, explain possibilities of life on any.

c—How are the planets kept in their path?

d—Describe a comet.

e—Why are meteors called "shooting stars"?

THE MOON

1—Make a drawing to show how the sun and moon eclipses are caused.

2—Describe the importance of the moon as follows:

a—How does the moon get its different shapes?

b—How does the moon cause tides?

c—How does the moon cause both kinds of eclipses?

d—Why could no life exist on the moon?

THE CAUSE OF THE SEASONS

1—Make a drawing of the earth in 4 positions of its revolution around the sun.

2—Explain the results of the earth's rotation, revolution, and inclination as follows:

a—Explain the cause of day and night. Of years.

b—When do we get our longest day? Our shortest day?

c—Why do days change in length? Explain fully.

d—Show by drawing, how the angle of the sun's rays affects temperature. Explain briefly.

e—Sum up the reasons why Summer is warm and Winter cold.

TIME AND DIRECTION

1—What is meant by "up" and "down"?

2—How is east and west determined?

3—What is latitude and longitude?

4—What is the prime meridian?

5—What is a solar day? How does a civil day differ from it?

6—How is standard time determined? Why do we have time belts?

7—Why is it necessary to have an international date line?

THE STARS

1—Make a drawing of the Big Dipper in four positions about the North Star.

2—Why is the sun our most important star?

3—How do other stars compare with the sun?

4—How were the constellations and stars named?

5—Name 5 constellations and 5 stars prominent in the sky.

6—What is the Milky Way?

The Cartesian Diver

A. W. Stewart
Kent State College, Ohio

As ordinarily used the Cartesian diver is a very interesting application of Archimedes' principle, Pascal's principle, and Boyle's law. If a tall graduate is used instead of a bottle, the law which states that pressure in a liquid is proportional to depth, is also involved. If the adjustment of the diver has been very carefully made and a graduate about two feet high is used as the container, it will be found that, when the diver is caused to go to the bottom by the application of pressure on the surface of the water, it will remain there even after the pressure is removed. Of course, the explanation is that the additional pressure due to the depth of the water in the tall graduate is sufficient to compress the air in the diver and thus reduce the displacement. It can be made to rise to the surface again by reducing the air pressure at the surface slightly below normal air pressure.

Still another law will be shown by the diver if the adjustment has been carefully made. If, in a warm room, the diver just sinks to the level of the surface, it will sink to the bottom when it is placed out in cold air and time allowed for the water to cool. When it is returned to the warm room and allowed to come to the temperature of the room, the diver will rise to the surface. The change in temperature causes a change in the volume of the air enclosed in the diver and hence a change in the buoyancy. It is, therefore, an illustration of the temperature-volume gas law.

Figure 1 shows a convenient arrangement for applying a varying pressure on the surface of the water. A one-hole rubber stopper is placed in the top of the graduate and a short glass tube inserted. To this glass tube is connected a rubber tube as shown in the figure. A very small amount of mercury is poured into the tube, after which the rubber stopper is removed from the graduate and then replaced again. The air over the water in the graduate is now at normal air pressure. If the rubber tube is now lifted as shown in A, the mercury will run down the tube towards the graduate,

compressing the air over the water and raising its pressure slightly above that of the outside air. Of course, this causes the diver to descend. When the free end of the rubber tube is lowered, the mercury runs back from the graduate, allowing the air to expand into the space thus resulting. This, in turn, reduces the pressure over the water to slightly less than the outside air pressure and the diver comes to the surface.

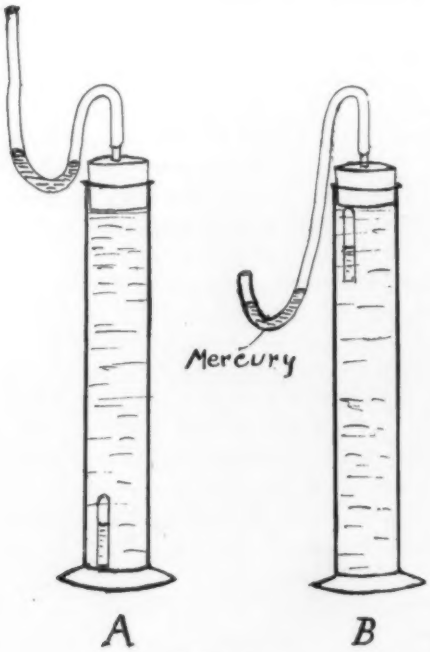

Figure 1

The arrangements of parts is easily made, is convenient and effective in use, and simplifies very much the use of the Cartesian diver.

Shattering the Atom [1]

A feature article, written by William L. Laurence in "The New York Times" for January 4, 1930, states that the award of $1,000 as given by the American Association for the Advancement of Science at the recent meeting in Cleveland, was given to Dr. M. A. Tuve, Dr. L. R. Hafsted, and Dr. O. Dahl, for their paper on "Experiments With High Voltage Tubes," which was given before the American Physical Society. This 2,000,000-volt X-ray tube is the result of some years of patient experimentation, and delivers radiation equivalent to $182,000,000 worth of radium. The article that follows discusses some features of this important investigation.—*Editor's Note.*

Scientists of the Department of Terrestrial Magnetism of Carnegie Institution have succeeded in producing at the laboratories in Washington a higher electrical voltage than man has hitherto ever obtained. With relatively inexpensive apparatus, compact enough to be easily contained in a small-sized room, they have developed an electrical pressure of more than 5,200,000 volts. Dr. G. Breit and Dr. M. A. Tuve, who have been working on this problem for several years, and their associates, are confident that when the need arises even greater voltages can be obtained by the method which they have developed.

But few high-voltage equipments are in existence. Of these the General Electric installation at the company's Pittsfield works, built at enormous expense, is the largest. With this equipment a voltage of 3,600,000 has been obtained. The California Institute of Technology, at Pasadena, has an equipment with a capacity of 1,500,000 volts; Stanford University has a 1,000,000-volt test-set and there are two or three installations in Europe of about the same capacity.

These mechanisms are designed for industrial testing, which requires high power as well as high voltage, while for scientific experiments a high-voltage equipment of small power is more suitable, being less expensive and more easily controlled. The apparatus which the Carnegie scientists have developed for laboratory purposes is of this type.

High Voltages as Tools

But why are scientists who are engaged primarily in the study of magnetism interested in producing voltages greater than those already available?

1 Reprinted from Press Service Bulletin of Carnegie Institution of Washington.

The answer is that these tremendous electrical pressures or voltages are needed as tools for the study of the structure of matter. The Institution Department of Terrestrial Magnetism has undertaken this work in the hope of extending knowledge of the nature of matter upon which any fundamental understanding of magnetism and therefore of the phenomena of terrestrial magnetism must rest.

Fig. 1. Dr. Tuve, Mr. Hafstad and Mr. Dahl with the high-voltage apparatus used in obtaining gamma and beta rays at the Department of Terrestrial Magnetism.

Furthermore, it is hoped, by means of high voltages, to produce in the laboratory, although on a small scale, radiations of the type which at present are supposed to be accountable for the observed phenomena of terrestrial electricity.

STRUCTURE OF MATTER

Scientific investigation reveals that matter, in all its forms, is made up of different kinds of atoms (more than ninety kinds in all) grouped into molecules, which, combined in countless numbers, constitute the objects we see about us.

The atoms themselves, all of about the same size, are extremely, almost inconceivably small, having a diameter of the order of a hundred-millionth of an inch. They all have similar structures, being built up of fundamental separate unit-particles of positive and negative electricity, called protons and electrons.

According to the latest theories of the nature of matter, these fundamental particles are "wave-packets" and matter, accordingly, wave motion. It is convenient, however, to use the older particle picture, even though the behavior of the "particles" may suggest that of ripples or wavelets.

Each atom has a central positively charged nucleus which is surrounded by an atmosphere of electrons whose number and configuration determine the kind of an atom it is, whether oxygen, sodium, platinum, radium, or some other of the ninety odd chemical elements of which matter is composed.

SIZE OF THE ATOM

It is known that almost the entire mass of the atom is located in this central nucleus, which is very much smaller than the atom itself, having a diameter of the order of one ten-thousandth of one-hundredth millionth of an inch. That is, the heavy part of an atom occupies only about one-hundredth millionth of the total volume of the whole atom. To express this volume in cubic centimeters the decimal point and 36 zeroes must precede the digit. Such magnitudes defy the human imagination even though they are arrived at and accepted by the human mind.

Indeed, to gain any conception of the minuteness of atoms and of their component parts, figures must be abandoned and analogies resorted to. Scientists have amused themselves by suggesting such analogies. For example, they say that if a drop of water were magnified to the size of the earth the constituent atoms would be the size of footballs.

Or again, if the atoms in a tumbler of water were thoroughly mixed with all the water in the world and the tumbler

again filled it would contain two thousand of the original atoms.

Still another says, in speaking of the ultra-minuteness of the nucleus, if the nucleus of a hydrogen atom were brought up to the size of a pea the single electron in the atom would be represented by a sphere 30 feet in diameter, and the circumference of the atom itself by a circle having a diameter of 600 miles.

Modern microscopes are very powerful and can magnify several thousand times, but in dealing with objects of such extraordinarily small diameters the microscope fails the scientist long before this degree of minuteness is reached because atomic dimensions are thousands of times smaller than the wave-lengths of ordinary light. Indirect methods must be employed.

The brilliant successes achieved in the study of the atom are due to the fact that instruments have been devised and methods evolved by means of which atoms can be disrupted into their constituent particles, the protons and electrons. The results of the breakdown of the structure can be seen. Thus positive conclusions are reached about the nature, behavior, and composition of a thing which is far too small ever to be seen.

ATTACKING THE ATOM

Scientists succeeded very well in the study of the external structure of the atom with the tools at their command, but difficulties presented themselves when they attempted to learn about its nucleus. They discovered that here was a thing that remained totally unresponsive to such agencies as high temperatures, extreme cold, enormous pressures, chemical explosions, and the like.

Not until Sir Ernest Rutherford began bombarding the nuclei of atoms with the projectiles fired off from radium, which move at tremendous velocities, did anything happen. He found, however, that when a hit was scored the nucleus broke up, producing, in so doing, certain effects which he was able to observe.

Thus, through employing certain high-speed particles given off by radium as it spontaneously disintegrates, a method was hit upon of shattering the nuclei of atoms thereby enabling the scientist to learn about the nuclear structure. Indeed,

what knowledge we now have of atomic nuclei has been gained solely through the study and use of this wonder-working element, radium, and its by-products.

TRANSMUTATION OF ELEMENTS

Only a beginning, however, has been made in this fascinating study. The door to the mysteries hidden in the atomic nucleus has been but barely stirred. Scientists are on the tiptoe of expectancy, for they feel that they have come close to fundamental secrets of matter. Indeed, Rutherford already has accomplished on a very minute scale the artificial transmutation of one element into another, a thing that the alchemists of old dreamed of doing. Scientists realize, however, that before the door to these mysteries can be opened wider, vastly more powerful tools than as yet they can marshal must be at their command.

Although these fast-moving, so-called "alpha-particles" emitted from the disintegrating atoms of radium represent the most concentrated energy known to science, the tool is an exceedingly expensive one owing to the rarity of radium and the cost of extracting it from the minerals with which it is found, and, what is even more important, radium presents the difficulty that it cannot be subjected to control.

The hope for a suitable and even more satisfactory substitute lies in the development of methods of securing high electrical voltages and, once they are obtained, of handling them safely under laboratory conditions. It is to the solving of these problems that Dr. Breit, Dr. Tuve and their associates have made a notable contribution.

METHOD OF OBTAINING HIGH VOLTAGES

In a lecture given under the auspices of Carnegie Institution, Dr. Tuve described the equipment and method which they have developed. He said:

"In the effort to develop a suitable laboratory source of high electrical pressures we adopted what is known as the high-frequency resonance coil. Coils operating on the same principle were constructed back in the 1890's by Nikola Tesla and Elihu Thomson, and similar ones have been used as spectacular demonstration toys for the past thirty years.

"Almost every high-school student has seen such a coil in operation. Sparks up to one foot long, representing pressures

of over 100,000 volts, may be taken into the body from such coils without harm because of the high frequency of the alternating current from the coil.

"The principle used is the same as that operating in the familiar acoustical example of a violin string vibrating 'sympathetically' when the string, tuned to the same note, is struck on a nearby piano. The same principle of 'resonance' or 'tuning' is also familiar to all radio enthusiasts.

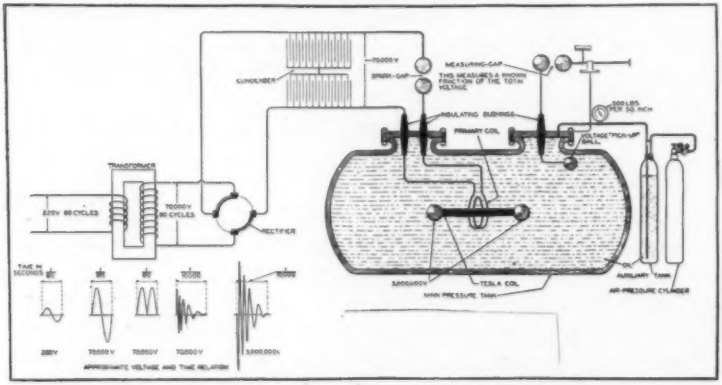

Fig. 2. Schematic diagram of 5,000,000-volt apparatus.

THE HIGH-VOLTAGE COIL

"The high-voltage coil itself consists of 8,000 turns of silk-insulated copper wire wound on a single layer on a Pyrex glass tube three inches in diameter and 36 inches long. This coil is immersed in an insulating coil, such as is used in all electrical transformers, and the ends of the coil are fitted with metal caps eight inches in diameter, whose rounded surfaces prevent spark-discharges out into the oil when the caps are raised to such high voltages by the action of the coil.

"The coil is excited to the high voltage by means of a primary circuit consisting of a large glass-plate condenser, a spark-gap, and a primary coil of two turns of copper tubing wound about the middle of the high-voltage coils and spaced some distance from it in the oil. The condenser and primary coil are adjusted to be electrically 'in tune' with the high-voltage coil.

"The condenser is charged to 50,000 or 100,000 volts by

means of an ordinary high-voltage X-ray machine, and when it discharges through the spark-gap the surges of current in this primary circuit by 'resonance' set the high-voltage coil into oscillation and build up the very high voltages (of the order of millions of volts) between the two balls on its ends.

INSULATED WITH OIL

"Surrounding the high-voltage coil with oil is an important feature of the method. An ordinary Tesla coil operating in air will not go to voltages higher than 300,000 to 400,000 because of the large sparks and streamers and 'corona discharges' which occur from all parts of the coil, but when this spectacular display is prevented by immersing the coil in oil the energy which would ordinarily be used up by sparks goes into raising the coil to a very much higher voltage.

"It was found that voltages up to about 3,000,000 were readily obtainable by using a coil of this type in an ordinary open tank, but above this voltage, sparks from the caps on the ends of the coil would flash out into the oil. By placing the high-voltage coil inside of a large steel tank filled with oil under a pressure of 500 pounds to the square inch, we were able to obtain over 5,000,000 volts. The pressure on the oil served to increase its insulating value. By slight changes in the design of the coil even higher voltages can be obtained when they are desired."

ENORMOUS ENERGY NEEDED TO BREAK UP NUCLEUS

If the electrically-charged particles of which an electric current is composed are released between two metal electrodes to which a high voltage is applied, the particles will move toward the electrodes with tremendous speeds due to the electrical attraction. If the particles are to attain full speed and maximum energy, they must be prevented from colliding with atoms of the air in their travel toward the electrodes. These electrodes therefore must be enclosed in a tube which is exhausted to a very high vacuum. When the electrons are released at one electrode of a vacuum tube to which a high voltage is applied, they bombard the other electrode with speeds approaching the velocity of light, which is 186,000 miles per second.

It is fairly easy with this method to knock electrons out of their normal positions in the atoms of a given element used

as a target. Comparatively low voltages suffice to give a stream of electrons or positively-charged atoms, used as projectiles, sufficient energy to accomplish this. But in order to penetrate the central massive structure of the atom, the nucleus, and disrupt it, the speed of these projectiles and consequently their hitting power, must be increased enormously. This can be accomplished only by increasing the electrical pressure applied to the tube until it is of the order of several million volts.

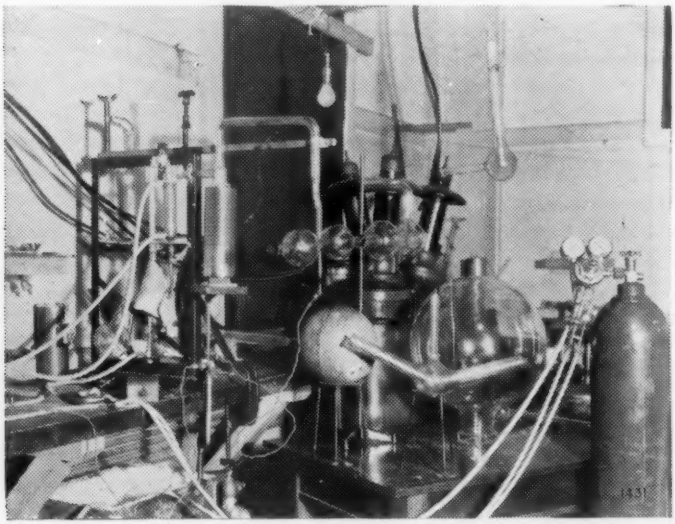

Fig. 3. Vacuum tubes and apparatus for use in high voltage experiments.

Such voltages would give to the stream of electrons or atomic projectiles speed and energy comparable to the alpha-particles of radium which Sir Ernest Rutherford used in the pioneer attack upon the nucleus of the atom. Not only would the speeds and energies of radium particles be duplicated, but the number of projectiles would be far greater than that obtained from any radium source. Even though the current through such a high-voltage tube were no larger than that used in an ordinary X-ray tube, if the voltage were continuously applied to the tube as many high-speed particles would be produced as would emanate from several tons of radium.

HIGH-VOLTAGE TUBES REQUIRED

However, now that a practicable method of securing such high voltages has been developed, another serious difficulty is encountered, the difficulty of obtaining vacuum tubes which will withstand the terrific strain which is produced.

At these tremendous voltages the glass is subjected to very great electrical stresses. Stray electrons bombard it and unwanted electrical charges accumulate in unexpected places, with the result that the glass breaks down and a puncture results. A still greater difficulty lies in the fact that it is almost impossible to produce a vacuum tube which does not discharge violently at 500,000 volts or even less, thereby preventing the voltage across the electrodes from being increased above this discharge point.

On the urgent need for tubes capable of operating at extremely high voltages, Dr. Tuve says:

"In order to produce particles of sufficiently high speeds to penetrate the central massive structure of the atom, called the atomic nucleus, they must be speeded up enormously by being released at one of the electrodes of a vacuum tube to which several million volts is applied. The development of a vacuum tube that can withstand this strain is then the second phase of the problem. This part of the work is still in progress.

"An ordinary high-voltage X-ray tube will not stand more than about 300,000 volts. Various special types of tubes have been constructed which have withstood a pressure of about 1,000,000 volts, but as yet no tube has been evolved which serves satisfactorily at the high voltages needed for these atomic investigations. We have been able to operate one of our tubes at over 1,000,000 volts for a short time.

"Dr. Coolidge, of the General Electric Company, has developed a tube, the 'cathode-ray tube,' which operates satisfactorily at 900,000 volts and will probably go higher, and within the last few months Dr. Lauritzen and Dr. Bennett, of the California Institute of Technology, have operated several times at 1,000,000 volts, but the quest for a really 'high-voltage' tube still continues."

HIGH VOLTAGE IN INDUSTRY

Because the efficiency of X-ray production increases very rapidly with increase in voltage, such tubes would produce

terrifically intense X-radiation of an extremely penetrating kind. X-ray pictures could be taken through a whole building with such tubes and the X-rays obtained from them could probably be used in revealing flaws in castings many feet thick, whereas the effective range at present is but a few inches. In addition to these uses which can be foreseen, entirely new effects may be revealed when such powerful tubes are operated; the biological effects of such radiation, for instance, can hardly be predicted.

THE IMPELLING MOTIVE

While, doubtless, many opportunities will be discovered for the practical use of extreme voltages and of tubes adequate to stand the operating strain, nevertheless, the atomic physicist is spurred on to new accomplishments by the thought that he is coming close to the fundamental laws of matter. The closing words of Dr. Tuve's Institution lecture emphasize this impelling motive:

"The enthusiasm of the scientists who are engaged on this fascinating problem is fired by the possibility of learning new and fundamental facts about the nature of matter. They see not only the exquisite beauty of the internal structure of atoms, revealed as it is on an incredibly minute scale, but they are impressed also with the splendor of the universe out to the farthest stars.

"Modern astronomers have not only measured the appalling distances to the stars and to the island universes beyond our galaxy, but they have shown that the material atoms of our Earth are found in all the great celestial bodies throughout the unthinkably vast regions of space. Wherever their telescopes have pointed they have read the familiar story: 'You have literally in your hands the secrets of the Universe.' Men's minds have been fired with such thoughts. They have accepted the challenge of the Earth and of the skies, and each day is revealing to them new beauty and new truth."

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Chemistry for Today—William McPherson and William Edwards Henderson, both professors of Chemistry in Ohio State University and George Winegar Fowler, Supervisor of Science, Syracuse, N. Y.—Ginn and Company, Boston, 1930—xi + 588 pages—$1.80.

The name McPherson and Henderson has long been familiar in the field of secondary school chemistry. This latest contribution of these authors will therefore be given an audience in the best circles.

In the words of the authors, "This text is an outgrowth of 'Chemistry and Its Uses' embodying the fundamental features of that book but including so many new features that in reality it is a new text." This is very conservative. As a matter of fact it is a very attractive book. The illustrations are almost all new; and the other "new features" deserve more than passing notice. Two features especially are noteworthy: (1) devices which adapt it to students' use and (2) treatment of recent advances in chemistry.

Each of the chapters—of which there are forty-six—has a title, a descriptive sub-title and a brief motivating introduction. These seem particularly adapted to the high school level. Again at the end of each chapter the traditional summary textbook questions are organized into 3 divisions under the headings, (1) "Summary in Question Form"; (2) "Thought Questions" and (3) "For Honor Students." Considerable care has apparently been given to the formulation of these questions. They provide a thorough review of each topic; génuine stimulation of thinking along the lines of chemical aspects of life; and ample opportunity for the exercise of the abilities of students with a special interest in the subject.

The election theory, the structure of the atom and the theory of colloids are among the newer advances that excel in exposition adapted to the high school level. The topics of Ionization and chemical equilibrium are also particularly well done. On the other hand, in some cases the exposition of highly theoretical concepts appears somewhat too dogmatic. For example, the inclusion of drawings of atomic structure in new elementary texts and in revisions of old is quite the mode and no doubt is in response to popular demand. However, in the present state of controversy and intensive research in the border lines of chemistry and physics it would seem desirable to give even high school students a suggestion of the methods and varying points of view of the original investigators in these fields. Some acquaintance with the names and work of Moseley, Bohr, and Langmuir, for example, should be quite as educative as learning fixed line drawings of concepts of various atoms. However sponsored by authority today, these models on a plane surface are quite without counterpart in fact.

On the whole, the book is modern in its subject matter, its illustrations and its devices for class-room use. The style and vocabulary are adapted to the high school level but without any lowering of dignity or of scientific accuracy.—R. E. Horton.

Superior to all other ten texts that I have used.—A North Carolina high school teacher

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A Brief Course in Physics—1931—C. H. Lake and G. P. Unseld—474 pages—330 illustrations—$1.68—D. C. Heath and Co.

"A Brief Course in Physics" has an advantage over many texts, in the fact that there is less material to omit. Our texts have become so voluminous, that a teacher is at a loss to know what to eliminate. Many teachers will welcome a return to a smaller book of essentials. Even this book claims to have all the material a class can do in one year in large type, and additional material in smaller type. The book is well written, with clear explanations, and has the modern treatment of viewpoint and subject matter. Review problems at the end of each chapter and special questions for review at the end of the book, covering the entire subject matter, are very helpful in fixing the various laws and principles.

The Nature Activity Readers—1931—Book 1. Outdoor Land, 131 pages, 72 cts.—Book II. The Outdoor Playhouse, 175 pages, 76 cts.—Book III. The Outdoor World, 270 pages, 88 cts.—Authors: P. G. Edwards and J. W. Sherman—Published by Little, Brown and Co.

This attractive set of readers gives the child real facts rather than fairy tales, about nature. They do not lack interest because of this but rather the interest is keener, since the child can have similar experiences if he but follow out the activities suggested. Better than many readers in common use, these books prepare the children to take advantage of opportunities which may come to them for contacts and experiences with nature. Games called "Something to do," suggest many activities, and tests in the nature of games will show if the children are actually acquiring knowledge and are growing more observing and interested in the out-of-door world. The books are well made and illustrated with both black and color pictures.

The Carbon Compounds—1931—C. W. Porter—469 pages—$4.00—Ginn and Company.

This is the second revised edition of this work on organic chemistry. The present volume has better organization of subject matter than the older editions, and has new material, the result of recent researches, added. Part I. takes up the Aliphatic Compounds, Part II. the Aromatic Compounds, and Part III. is given over to general organic reactions.

Biological Foundations of Education—1931—Otis W. Caldwell—C. E. Skinner — J. W. Tietz — 534 pages — 116 illustrations — $2.72 — Ginn and Company.

In recent years there has been a growing idea that biology is a basic study, not merely as a useful science, but for all education. It is an outstanding contribution to teacher training and is of especial value in furnishing a background for the understanding of the educational process. Its close association with psychology and sociology makes it especially desirable for students in teachers colleges. We join the authors in "the hope that biological knowledge as here presented may contribute to a more purposeful development not only of the general philosophy of education, but of an individual philosophy of living."

Final Test for High School Physics—1930—A. W. Hurd—$2 per hundred — Bureau of Publication, Teachers College, Columbia University.

This series of tests (forms A, B, and C) may serve several purposes: 1. As an achievement test; 2. To measure efficiency of instructor; 3. To determine probable success of students in college physics.

Questions 1-38 include factual material and mathematical problems; 39-52 are multiple choice; 53-82 are missing word tests. The tests are the result of several years' refinement in actual study and are adapted for college preparatory classes.

Alternate Currents—1930—Calvin C. Bishop—317 pages—338 illustrations—$2.00—D. van Nostrand Company.

This book for technical and engineering students presupposes acquaintance with direct-current theory. It treats fundamental theory and suggests use of standard apparatus. Problems are used to test the student's progress.

Kostychev's Chemical Plant Physiology — 1931 — Translated and edited by C. J. Lyon—498 pages—45 illustrations—$6.00—P. Blakiston's Son and Company.

The treatment of the chemical aspects of plant physiology is clear and thorough. It is based on principles of methodology. It is essential that the reader be familiar with the fundamental principles of organic chemistry. On the whole, it appears to be about the best treatment of the subject, bringing in, as it does, the results of research of recent years. The chapter titles indicate the scope of the work: The foundation of chemical plant physiology; the assimilation of solar energy by green plants and the primary synthesis of organic compounds; chemo-synthesis and the assimilation of molecular nitrogen; plant nutrition with prepared organic compounds; carbohydrates and proteins: the transformations of these substances in plants, secondary plant substances, respiration and fermentation.

Lord Balfour in His Relation to Science—1930—Lord Rayleigh—46 pages—$1.00—The Macmillan Co.

This little volume gives an account of Lord Balfour's early life and development, his scientific thought, and his administrative work for scientific, industrial and medical research. The author draws upon his own intimate personal knowledge and recollections and diaries of relatives.